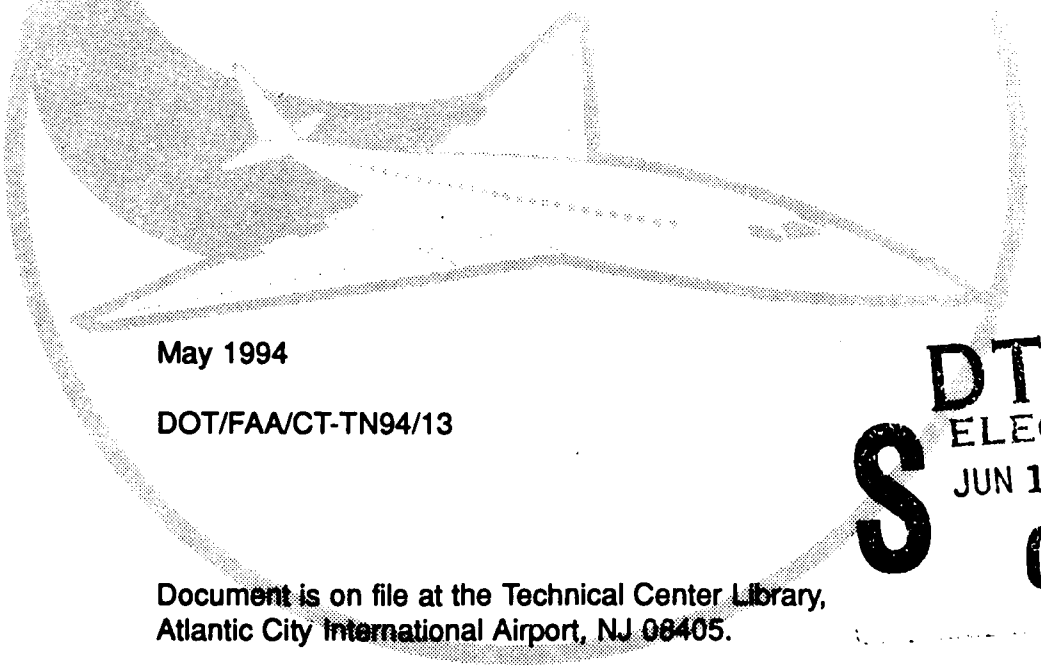
technical note technical note

VHF Direction Finder (VDF) Operational Test and Evaluation (OT&E) Integration and OT&E Operational Test Logs and Data

Eugene Barto
Robert Bernheisel
John Dyson
Joseph Pino



May 1994

DOT/FAA/CT-TN94/13

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16. Abstract

Preliminary Operational Test and Evaluation (OT&E) Integration and OT&E Operational testing was conducted on the Very High Frequency (VHF) Direction Finder (VDF) at the Green Bay, WI, Automated Flight Service Station (AFSS), from March 29 through April 9, 1993. Formal OT&E Integration and OT&E Operational testing was conducted from June 21 through June 24. Testing was categorized into the areas of integration and maintenance, display and keyboard functions, and operational flight testing.

This document provides the logs and processed data from the OT&E Integration and OT&E Operational tests. This document supplements the VHF Direction Finder (VDF) Operational Test and Evaluation (OT&E) Integration and OT&E Operational Test Report, DOT/FAA/CT-TN94/12.

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EXECUTIVE SUMMARY

The Direction Finder (DF) network is maintained and operated by the Federal Aviation Administration (FAA) as a position location service for aircraft. The present network is made up of a mix of tube-type and solid-state equipment. The tube-type equipment will be replaced by new solid-state equipment; the FA-10121, which incorporates operator task automation, remote maintenance monitoring, and control and certification capabilities.

Preliminary Operational Test and Evaluation (OT&E) Integration and OT&E Operational testing was conducted on the Very High Frequency (VHF) Direction Finder (VDF) at the Green Bay, WI, Automated Flight Service Station (AFSS), from March 29 through April 9, 1993, using software release 4.05. Formal OT&E Integration and OT&E Operational testing was conducted from June 21 through June 24, 1993, using VDF software release 4.07. Testing was categorized into the areas of integration and maintenance, display and keyboard functions, and operational flight testing. Flight testing used the Federal Aviation Administration (FAA) Technical Center Aero Commander 680E aircraft.

This document provides the logs and processed data from the OT&E Integration and OT&E Operational tests. This document supplements the VHF Direction Finder (VDF) Operational Test and Evaluation (OT&E) Integration and OT&E Operational Test Report, DOT/FAA/CT-TN94/12.

SECTION 1

PRELIMINARY OPERATIONAL TEST AND EVALUATION (OT&E) INTEGRATION AND OT&E OPERATIONAL TEST LOGS: MARCH 29 THROUGH APRIL 9, 1993

DIRECTION FINDER TEST OBSERVER/MONITOR NOTES

Test Category/Number: Flight Scenario 1 **Date:** 4/5/93 **Time:** 1:30 PM
Test Observer/Monitor: Bill Swart (SEIC ANN-600 support)
Observations/Comments:

Observations at IDCU #2 with Charlie Warner operating and Bob Bernhaisel taking data:

* Lost Positions two and three due to lack of pilot audio.

* Began getting other aircraft transmissions around positions three and four.

* Had AF technician change GRB audio level from -16 dB to 0 dB and squelch from -97 dB to -140 dB. This improved pilot audio.

* Position 6 was the transmission announcing that position 6 would be in 10 seconds.

* IDCU #2 operator stated aircraft passing over STE; within 5 seconds IDCU reported same.

* IDCU #2 was switched from Automatic Mode to Manual Mode prior to position 9.

* STE DF was deselected after position 12.

Direction Finder Test Mission Log

Test Category/Number: 3/Flight Scenario 1 **Date:** 04/05/93 **Time:** 13:35
Test Manager : John Dyson/Joe Pino
Hardware Configuration:
Software Configuration: CM Version 4.05

Personnel Name	Title	Function
John Dyson	Test Director	Test Director
Sam Barto	Computer Scientist	Lead Data Collector
Bob Bernheisel	Electronics Technician	Data Collector
Charlie Parks	ATZ-120	Data Collector/Monitor
Joe Pino	APMT	Test Monitor
Ron Lockhart	Support Engineer	Airborne Data Collector
Theos McKinney	Flight Test Pilot	Test Pilot
Dale Walker	AT Specialist	Floor IDCU Operator
Charlie Werner	AT Specialist	Training Room IDCU Operator

Discussion Items:

* AT Specialist provides a DF Approach to Green Bay Airport.

* Training given AT specialists will be assessed during scenario.

* DF reported positions at both floor and training room IDCU's will be compared against GPS derived aircraft data.

* Floor IDCU in manual mode; training room IDCU in automatic mode/manual mode.

Deviations/Discrepancies:

(1) Keyline inhibit not meeting intent of specification

- AT specialist keying mike after an aircraft transmission caused a strobe update even though strobe inhibit was enabled causing aircraft history to be lost.

Direction Finder Test Mission Log

Test Category/Number: 3/Flight Scenario 1 **Date:** 04/05/93 **Time:** 13:35
Test Manager : John Dyson/Joe Pino
Hardware Configuration:
Software Configuration: CM Version 4.05

(2) Channel selection illuminator was observed to extinguish upon some at specialist transmissions. Drop or block of received aircraft transmissions was observed upon at least 3 occurrences.

(3) Strobes and aircraft symbol was replaced in manual mode with strobe inhibit on D-1 upon several occurrences

- Observed at IDCU of training room and AFSS floor position.

(4) A strobe was placed at 189 (SFC site) on the IDCU in the training room while in automatic mode on several occasions. This occurred even during a continuous aircraft transmission.

Test Category/Number: Flight Scenario 1 **Date:** 4/5/93 **Time:** 13:35
Test Observer/Monitor: Charlie Werner, AT Specialist Green Bay
Observations/Comments:

On three occasions the equipment placed a strobe when I was in manual mode and had not depressed the strobe key.

On several occasions during the approach to Green Bay the equipment placed a strobe to 189 (the SFC site), not the ACFT. This occurred even during a continuous ACFT transmission.

DIRECTION FINDER TEST OBSERVER/MONITOR NOTES

Test Category/Number: Flight Scenario 1 **Date:** 4/5/93 **Time:** 13:35
Test Observer/Monitor: Dana K. Dias, (Pragmatics ANN-600 Support)
Observations/Comments: (IDCU# 1- the floor)

(1) During the scenario the system was operated in the "Manual Mode." I witnessed, although connected to the ICSS with keyline inhibit activated, whenever the operator communicated with the aircraft, a new placement was established. The intent of the keyline inhibit is to prevent ground to air transmission placements.

(2) The Grimm Audio Box located on the IDCU console would toggle off and on during the latter part of the scenario. Will check for a repeat of this occurrence during other flight scenarios.

(3) The operator displayed exceptional skill during DF approaches. The system responded well to all commands and provided the necessary assistance to orient the aircraft safely to an airport.

DIRECTION FINDER TEST SUMMARY FORM

Test Category/Number: 3/Flight Scenario 1 Date: 04/05/93
Observations/comments:

DF approaches conducted by AT specialist were considered very good from the test aircraft flight crew's vantage point; Shawano Lake was missed by approximately 2 miles.

Significant Anomalies/Deviations:

Keyline Inhibit did not meet intent of specification; channel selection illuminator extinguished during AT specialist transmissions upon several occasions; received aircraft transmissions were dropped or blocked on at least 3 occasions; strobes and aircraft positions symbols replaced in manual mode in strobe inhibit.

Preliminary assessment:

Further flight scenarios will allow more investigation of observed anomalies. The keyline inhibit observation appears to be noncompliant with the specification. Flight test went well overall with satisfactory coordination. Better communication is required between floor IDCU and training room IDCU personnel (ICSS in training room should allow pertinent frequency selections).

Grimm audio monitor on floor IDCU was noted as giving poor fidelity by some test monitors/observers and could be a reliability concern.

Different AT specialists will be used on further flight scenarios to allow a greater sample for training assessment.

A keyboard anomaly is speculated as a keyboard hardware failure (training room IDCU) and will be investigated prior to further flight testing.

Atch: Test Mission Log, As run test procedure, Test Conduct Log, Test Monitor/Observer Notes, Test Problem Reports.

Joseph P. Pino
Test Director

Direction Finder Test Mission Log

Category/Number: 3/Flight Scenario 2 **Date:** 04/06/93 **Time:** 9:05
Test Manager : Joe Pino/John Dyson
Hardware Configuration:
Software Configuration: CM version 4.05

Personnel Name	Title	Function
John Dyson	Test Director	Test Director
Sam Barto	Computer Scientist	Lead Data Collector
Bob Bernheisel	Electronics Technician	Data Collector
Charlie Parks	ATZ-120	Observer/Collector
Joe Pino	APMT	Test Monitor
Ron Lockhart	Support Engineer	Airborne Data Collector
Theos McKinney	Flight Test Pilot	Test Pilot
Kevin Hodina	AT Specialist	Floor IDCU Operator
Bill Swart	ANN-600 Support Engineer	Training Room IDCU Operator

Discussion Items:

* Induced failure of RMMC 1 at scenario point #20 via powerdown.

Deviations/Discrepancies:

(1) RMMC 2 was failed via powerdown approximately 10 minutes after assuming primary status. System had to be manually initialized since RMMC 1 had not manually been set to backup mode after previously induced failure. AF technician successfully restored the system. Data could not be taken after event #20 due to required initialization.

(2) System was accidentally reinitialized early in the scenario via operator error at IOT-2. The operator at IOT-2 was not the AF technician, but project office support requested by the APMT.

DIRECTION FINDER TEST SUMMARY FORM

Test Category/Number: 3/Flight Scenario 2 **Date:** 04/06/93

Observations/Comments:

Good AT specialist operations.

Significant Anomalies/Deviations:

None.

Preliminary Assessment:

Switchover at RMMC 1 to RMMC 2 upon induced failure of RMMC 1 by powerdown was nearly transparent to the operator. An audible alarm and a COMM failure were indicated to the operator as expected.

Training given AT specialists has been further reinforced via this scenario and overall operator performance.

Atch: Test Mission Log, as run test procedures, Test Conduct Log, Test Monitor/Observer Notes, Test Problem Reports.

Joseph P. Pino
Test Director

Direction Finder Test Mission Log

Category/Number: 3/Flight Scenario 3 **Date:** 04/06/93 **Time:** 13:15
Test Manager : Joe Pino/John Dyson

Hardware Configuration:
Software Configuration: CM version 4.05

Personnel Name	Title	Function
John Dyson	Test Director	Test Director
Sam Barto	Computer Scientist	Lead Data Collector
Bob Bernheisel	Electronics Technician	Data Collector
Joe Pino	APMT	Test Monitor
Ron Lockhart	Support Engineer	Airborne Data Collector
Theos McKinney	Flight Test Pilot	Test Pilot
Bill Swart	ANN-600 Support Engineer	Training Room IDCU Operator
Mike Shew	AT Specialist	Floor IDCU Operator
Kevin Harrington	FAA ATR-220	Data Collector/Monitor

Discussion Items:

* RMMC 1 will be failed by powerdown after flight scenario event #7
* RMMC 2 will be failed by powerdown after flight scenario event #13

Deviations/Discrepancies:

(1) Operator lost communications with test aircraft disallowing the collection of data at scenario event #16. This is not a system problem, however.

(2) System rebooted spontaneously near scenario event #19 - prior to, (GMT 19:57:20). Last time noted on IDCU from RMMC #1 was at GMT 19:46:xx. Dumped message data for RMMC #1 & #2 for analysis.

(3) Keyboard located audible alarm not loud enough for operational situations.

DIRECTION FINDER TEST SUMMARY FORM

Test Category/Number: 3/Flight Scenario 3 **Date:** 04/06/93

Observations/Comments:

AT specialists prefer use of VDF to existing fielded system (FA-9964 DDF, FA-5530).

Significant Anomalies/Deviations:

Spontaneous reboot of system prior to scenario event #19 causing truncation of flight scenario.

Preliminary Assessment:

Intentional failures of RMMC#1 and RMMC#2 resulted in acceptable recoveries nearly transparent to the operator. It was the opinion of several test observers that the audio level of the audible alarm was not high enough to be of optimum use in a true operational environment.

Spontaneous reboot of system during scenario requires further investigation, RMMC1 was set to primary with RMMC 2 as backup. A nontest personnel (automatic) switch was noted at GMT 19:52:50 where RMMC2 assumed primary status for some as yet unknown reason. At GMT 20:02:51, a NO COMMS alarm was sounded at the IDCU followed by a system initialization (reboot). The message buffer data for RMMC1 &2 was printed out by the assigned AF technician for analysis. This occurrence must be investigated in an attempt to determine the cause(s) since it could be a liability during actual field operation if it occurs often.

Atch: Test Mission Log, as run test procedures, Test Conduct Log, Test Monitor/Observer Notes, Test Problem Reports.

Joseph T. Pino
Test Director

Direction Finder Test Mission Log

Category/Number: 3/Flight Scenario 5 **Date:** 04/06/93 **Time:** 16:15
Test Manager : Joe Pino

Hardware Configuration:
Software Configuration:

Personnel Name	Title	Function
John Dyson	Test Director	Light Aircraft Pilot Support
Sam Barto	Computer Scientist	Lead Data Collector
Bob Bernheisel	Electronics Technician	Data Collector
Joe Pino	APMT	Test Monitor
Ron Lockhart	Support Engineer	N50 Aircraft Pilot Support
Theos McKinney	Flight Test Pilot	Test Pilot
Bill Swart	ANN-600 Support Engineer	Training Room IDCU Operator
Paul Hilsher	AT Specialist	Floor IDCU Operator

Discussion Items:

* Two-aircraft scenario intended to measure AT specialists' ability to handle two aircraft.

Deviations/Discrepancies:

* Late takeoff by N50 Aerocommander test aircraft caused additional scenario runtime.

* High traffic at time of flight caused additional operator burden (AT specialist had not been trained in handling two aircraft simultaneously).

DIRECTION FINDER TEST SUMMARY FORM

Test Category/Number: 3/Flight Scenario 5 **Date:** 04/06/93

Observations/Comments:

Headings given by DF operator/ AT specialist were considered very good by test flight personnel. Some ranges were off up to 4 miles in the vicinity of Sturgeon Bay (Navaid restrictions must be taken into account during data analysis).

Significant Anomalies/Deviations:

Strobes off Stevens Point (STE) 9964 DF site were static and similar to someone having placed a line on the IDCU display.

Preliminary Assessment:

Another two aircraft situations will be incorporated into flight scenario 4 in order to further assess real life two aircraft encounters. Restrictions on some of the Navaids may have attributed to range inaccuracies.

Atch: Test Mission Log, as run test procedures, Test Conduct Log, Test Monitor/Observer Notes, Test Problem Reports.

Joseph P. Pino
Test Director

Direction Finder Test Mission Log

Category/Number: 3/Flight Scenario 4 **Date:** 04/07/93 **Time:** 9:30
Test Manager : John Dyson/ Joe Pino

Hardware Configuration:
Software Configuration: CM Version 4.05

Personnel Name	Title	Function
John Dyson	Test Director	Test Monitor
Sam Barto	Computer Scientist	Lead Data Collector
Bob Bernheisel	Electronics Technician	Data Collector
Joe Pino	APMT	Test Director
Ron Lockhart	Support Engineer	Airborne Data Collector
Theos McKinney	Flight Test Pilot	Test Pilot
Rick Akers	AMA-571	Data Collector
Will Showers	AT Specialist	Floor IDCU Operator
Charlie Werner	AT Specialist	Training Room IDCU Operator

Discussion Items:

* Ad hoc aircraft scenario to be instituted by ATM-110 for comparison of VDF operator reported positioning reference terminal ARTS III secondary surveillance reports after scenario event #12 with test aircraft inbound to Green Bay Airport.

Deviations/Discrepancies:

* Audio dropout or block of aircraft transmission occurred near completion of scenario event 12.

* A 17-mile difference was noted between reported aircraft position versus VDF triangulation using RHI and MQT.

- Distance to RHI was 62 miles which is beyond recommended usable distance (40 nmi) for a DF site.

Direction Finder Test Mission Log

Category/Number: 2.1.1.1/2.1.1.2 **Date:** 04/07/93 **Time:** 15:20
Test Manager : John Dyson/ Joe Pino

Hardware Configuration:
Software Configuration: CM Version 4.05

Personnel Name	Title	Function
John Dyson	Test Director	Test Director
Sam Barto	Computer Scientist	Test Operator
Bob Bernheisel	Electronics Technician	Data Collector
Joe Pino	APMT	Test Monitor
Ed Lugo	AOS-240	Test Observer

Discussion Items:

* Help function key checkout.
* IDCU map and symbols checkout.

Deviations/Discrepancies:

* Minor deviations noted in help text of several functions

- no operational impact.

Direction Finder Test Mission Log

Test Category/Number: 2.2.7.3 **Date:** 4/09/93 **Time:** 7:00
Test Manager: John Dyson/Joe Pino
Hardware Configuration:
Software Configuration: CM Version 4.05

Personnel Name	Title	Function
John Dyson	Test Director	Test Director
Sam Barto	Computer Scientist	Lead Data Collector/Test Operator
Bob Bernheisel	Electronics Technician	Data Collector
Joe Pino	APMT	Test Monitor
Ed Lugo	AOS-240	Test Observer

Discussion Items:

* Grounding of RMMC equipment and IDCU racks
* Maintenance menu function checkout

Deviations/Discrepancies:

* System crash noted at beginning of test exercise
- Occurred during previous night according to message data derived at IOT-2

DIRECTION FINDER TEST SUMMARY FORM

Test Category/Number: 3/Flight Scenario 4 **Date:** 04/07/93

Observations/Comments:

Scenario event #5 data collection was missed due to loss of communication with test aircraft. A loss of audio occurred at the floor IDCU requiring the operator to re-depress the channel selection button. This occurred near completion of DF approach (scenario event 12). DF approach was very good as reported by test aircraft flight crew. Ad hoc scenario run by ATM-110 upon completion of event 12 yielded acceptable results. Two aircraft not utilized as desired due to weather conditions.

Significant Anomalies/Deviations:

* Drop or block of received aircraft transmission audio occurred in one instance (previously observed on 04/05/93 executing flight scenario 1).

* 17-mile difference noted before scenario event 7 between VDF and aircraft GPS based positions. Strobes were off RHI & MQT, RHI at 62 miles (beyond usable range).

Preliminary Assessment:

* Ad hoc scenario conducted by ATM-110 upon test aircraft approach to Green Bay. Green Bay approach radioed AFSS for assistance in using the VDF to provide positional information. The intent was to simulate a situation where radar contact is lost. Aircraft was under IFR prior to simulated loss of radar contact. Aircraft position as reported to ATC by the VDF operator was compared to ARTS III radar beacon reports presented on the ARTS III display. Position was accurate upon visual inspection. A single strobe off GRB DF site and triangulation off a VOR was used by the VDF operator to report position.

* IDCU updates without actual change of presented information was distracting to operator. Labels move around even though strobes don't change. "Sideways" movement of aircraft due to position variances being reported by the VDF was annoying to AT specialist. Aircraft was noted as moving 4-5 miles sideways at 1000 feet altitude and 35 miles from DF site. Operator comment was that training on the DF site simulator/emulator was significantly different than working a live aircraft.

DIRECTION FINDER TEST SUMMARY FORM

Test Category/Number: 3/Flight Scenario 4 **Date:** 04/07/93

Observations/Comments:

Preliminary Assessment (continued):

* It was noted that air traffic opinions are that DF approaches should only be conducted within Navaid limits.

Atch: Test Mission Log, As run test procedure, Test Conduct Log, Test Monitor/Observer Notes, Test Problem Reports.

Joseph P. Pino
Test Director

Direction Finder Test Mission Log

Category/Number: 2.1.1.3/2.1.2 **Date:** 04/08/93 **Time:** 8:30
Test Manager: John Dyson/Joe Pino

Hardware Configuration:
Software Configuration: CM Version 4.05

Personnel Name	Title	Function
John Dyson	Test Director	Test Operator/Monitor
Sam Barto	Computer Scientist	Test Operator
Bob Bernheisel	Electronics Technician	Data Collector
Joe Pino	APMT	Test Monitor
Charlie Parks	ATZ-120	Test Observer
Ed Lugo	AOS-240	Test Observer
Chuck Patrick	AF Technician	Test Observer
Bill Swart	ANN-600 Support Engineer	Test Observer

Discussion Items:

* IDCU map and symbols checkout
* IDCU database consistency checkout

Deviations/Discrepancies:

* IDCU 2 locked up after default scale key was depressed requiring a hard reset, a coldstart instituted at IOT-2 had no effect.
* Data derived from IOT-2 indicates that key depression was probably not responsible for IDCU lockup (mutually exclusive events.)

Direction Finder Test Mission Log

Test Category/Number: 2.2.3 **Date:** 4/08/93 **Time:** 11:20
Test Manager: Joe Pino

Hardware configuration:
Software Configuration: CM version 4.05

Personnel Name	Title	Function
Sam Barto	Computer Scientist	Test Director
John Dyson	Test Director	Test Monitor
Bob Bernheisel	Electronics Technician	Data Collector
Joe Pino	APMT	Test Monitor
Ed Lugo	AOS-240	Test Monitor

Discussion Items:

* RMMC control checkout

Deviations/Discrepancies:

SECTION 2

OPERATIONAL TEST AND EVALUATION (OT&E) INTEGRATION AND OT&E OPERATIONAL TEST LOGS: JUNE 21 THROUGH JUNE 24, 1993

DIRECTION FINDER TEST SUMMARY FORM

Test Category/Number: 3/Flight Scenario 1 **Date:** 06/21/93

Observations/Comments:

AT specialist displayed great skill during entire scenario. Using DF sites beyond 40 nmi has to be taken into consideration with respect to positional accuracy.

Significant Anomalies/Deviations:

None

Preliminary Assessment:

Limitations of DF sites beyond 40 nmi were manifested in displacement during triangulation.

Time-distance problem appeared to overburden IDCU operator.

Intentional interruption/failure of primary RMMC2 resulted in an acceptable switchover.

Gross changes in aircraft position were not considered an operational problem since displacements were obviously inaccurate; operator asks for another transmission from aircraft to update display.

Atch: Test Mission Log, As run Test Procedure, Test Conduct Log, Test Monitor/Observer Notes, Test Problem Reports.

Joseph P. Pino
Test Director

DIRECTION FINDER TEST MISSION LOG

Test Category/Number: 3/Flight Scenario 1 **Date:** 6/21/93 **Time:** 15:00
Test Manager: John Dyson/Joe Pino
Hardware Configuration:
Software Configuration: CM Version 4.07

Personnel Name	Title	Function
John Dyson	Test Director	Test Director
Sam Barto	Computer Scientist	Lead Data Collector
Bob Bernheisel	Electronics Technician	Data Collector
Gib Shade	AOO AFSS	Data Collector
Joe Pino	APMT	Test Monitor
Ron Lockhart	Support Engineer	Airborne Data Collector
Theos McKinney	Flight Test Pilot	Test Pilot
Mike Shew	AT Specialist	Floor IDCU Operator
Charlie Weaver	AT Specialist	Training Room IDCU Operator
Kevin Harrington	ATR-220	Test Monitor

Discussion Items:

* DF reported positions will be compared to aircraft GPS derived data.
* AT specialist provides a DF approach to Stevens Point Airport.
* RMMC 2 (active) was set to cause alarm at scenario event #11. Interrupt button was depressed on computer front panel.
* Operations used system in automatic mode.

DIRECTION FINDER TEST MISSION LOG

Test Category/Number: 3/Flight Scenario 1 **Date:** 6/21/93 **Time:** 15:00
Test Manager: John Dyson/Joe Pino
Hardware Configuration:
Software Configuration: CM Version 4.07

Deviations/Discrepancies:

* Feedback on audio channel.

* Anomaly on time-distance problem.

* 15 nmi displacement noted with strobe 47 nmi off STE triangulated with GRB.

* 12 nmi DF reported versus 20 NMI with GPS after scenario event 11 near GRB.

* Late takeoff of Aerocommander N50 test aircraft due to head temperature gauge failure.

DIRECTION FINDER TEST SUMMARY FORM

Test Category/Number: 3/Flight Scenario 2 **Date:** 06/22/93

Observations/Comments:

* Time-Distance calculation performed before scenario event #15 was accurate per AT operational standards.

* Stevens Point (STE) FA9964 site showed errors of 3 nmi at 60 nmi - good site environment characteristics.

* Activation of emergency feature between scenario events 17&18 showed accurate positional information.

Significant Anomalies/Deviations:

System took approximately 20 seconds to alarm after induced failure of primary RMMC1. Operator attempted to change frequencies during this time period and system did not respond.

Preliminary Assessment:

* Time-distance calculation based on DF information was considered accurate per air traffic (AT) operational standards. Aircraft DME and time-distance calculation matched.

* Induced failure of primary RMMC 1 resulted in proper system switchover. RMMC 2 assumed primary status as required.

* In emergency mode when there is no aircraft placement, DF goes to previous placement.

* Twenty second alarm period could possibly be shortened via change of software setable parameter.

DIRECTION FINDER TEST SUMMARY FORM

Test Category/Number: 3/Flight Scenario 2 **Date:** 06/22/93

Preliminary Assessment (continued):

* Oscillations in strobe positions was noted when receiving information from DF antennas beyond 40 nmi, the useful range of this navigational aid.

* AT specialists displayed much skill in operating the DF. One specialist had not used system for 3 months yet displayed great proficiency.

Atch: Test Mission Log, as run test procedures, Test Conduct Log, Test Monitor/Observer Notes, Test Problem Reports.

Test Director

DIRECTION FINDER TEST MISSION LOG

Test Category/Number: 3/Flight Scenario 2 **Date:** 6/22/93 **Time:** 9:06
Test Manager: John Dyson/Joe Pino
Hardware Configuration:
Software Configuration: CM version 4.07

Personnel Name	Title	Function
John Dyson	Test Director	Test Director
Sam Barto	Computer Scientist	Lead Data Collector
Bob Bernheisel	Electronics Technician	Data Collector
Joe Pino	APMT	Test Monitor
Ron Lockhart	Support Engineer	Airborne Data Collector
Kevin Harrington	ATR-220	Data Collector
Gib Shade	AOO-AFSS	Data Collector
Theos McKinney	Flight Test Pilot	Test Pilot
Dale Walker	AT Specialist	IDCU Operator - Floor
Kevin Hodina	AT Specialist	IDCU Operator - Floor
Charlie Werner	AT Specialist	IDCU Operator - Training Room

Discussion Items:

* Will perform time-distance problem near scenario event 15
* Floor IDCU in manual mode; training room IDCU in automatic mode.
* Aircraft placed manually on floor IDCU via holding strobe.
* Floor IDCU put in automatic mode after scenario event #5; back in manual mode at scenario event #11; automatic mode after event 14.
* Induced failure of RMMC1 during scenario event 18.

DIRECTION FINDER TEST MISSION LOG

Test Category/Number: 3/Flight Scenario 2 **Date:** 6/22/93 **Time:** 9:06
Test Manager: John Dyson/Joe Pino
Hardware Configuration:
Software Configuration: CM version 4.07

Deviations/Discrepancies:

* Oscillations in strobe positions noted when information received from DF antenna site beyond 40 nmi.

* No audio being received from La Crosse FA9964 DF site (Not a test issue).

* In emergency mode when there is no aircraft placement, DF goes to previous placement.

DIRECTION FINDER TEST MISSION LOG

Test Category/Number: 3.1/alignment orbitals **Date:** 6/23/93 **Time:** 9:10
Test Manager: John Dyson/Joe Pino
Hardware Configuration:
Software Configuration: CM Version 4.07

Personnel Name	Title	Function
John Dyson	Test Director	Test Director
Sam Barto	Computer Scientist	Lead Data Collector
Bob Bernheisel	Electronics Technician	Data Collector
Joe Pino	APMT	Test Monitor
Ron Lockhart	Support Engineer	Airborne Data Collector
Kevin Harrington	ATR-220	Data Collector
Gib Shade	AOC-AFSS	Test Monitor
Theos McKinney	Flight Test Pilot	Test Pilot
Dale Walker	AT Specialist	IDCU Operator - Floor
Mike Shew	AT Specialist	IDCU Operator - Floor

Discussion Items:

* Marquette FA 10121 Site accuracy
* Rhinelander FA 9964 Site accuracy
* 10 nmi radius orbitals, 5 seconds radio transmissions, 1 minute spacing
* 20 nmi arc around Rhinelander FA 9964

Deviations/Discrepancies:

DIRECTION FINDER TEST MISSION LOG

Test Category/Number: 1.2, 2.1.1 **Date:** 6/23/93 **Time:** 9:10
Test Manager: John Dyson/Joe Pino
Hardware Configuration:
Software Configuration:

Personnel Name	Title	Function
John Dyson	Test Director	Test Director
Sam Barto	Computer Scientist	Lead Data Collector
Bob Bernheisel	Electronics Technician	Data Collector
Joe Pino	APMT	Test Monitor

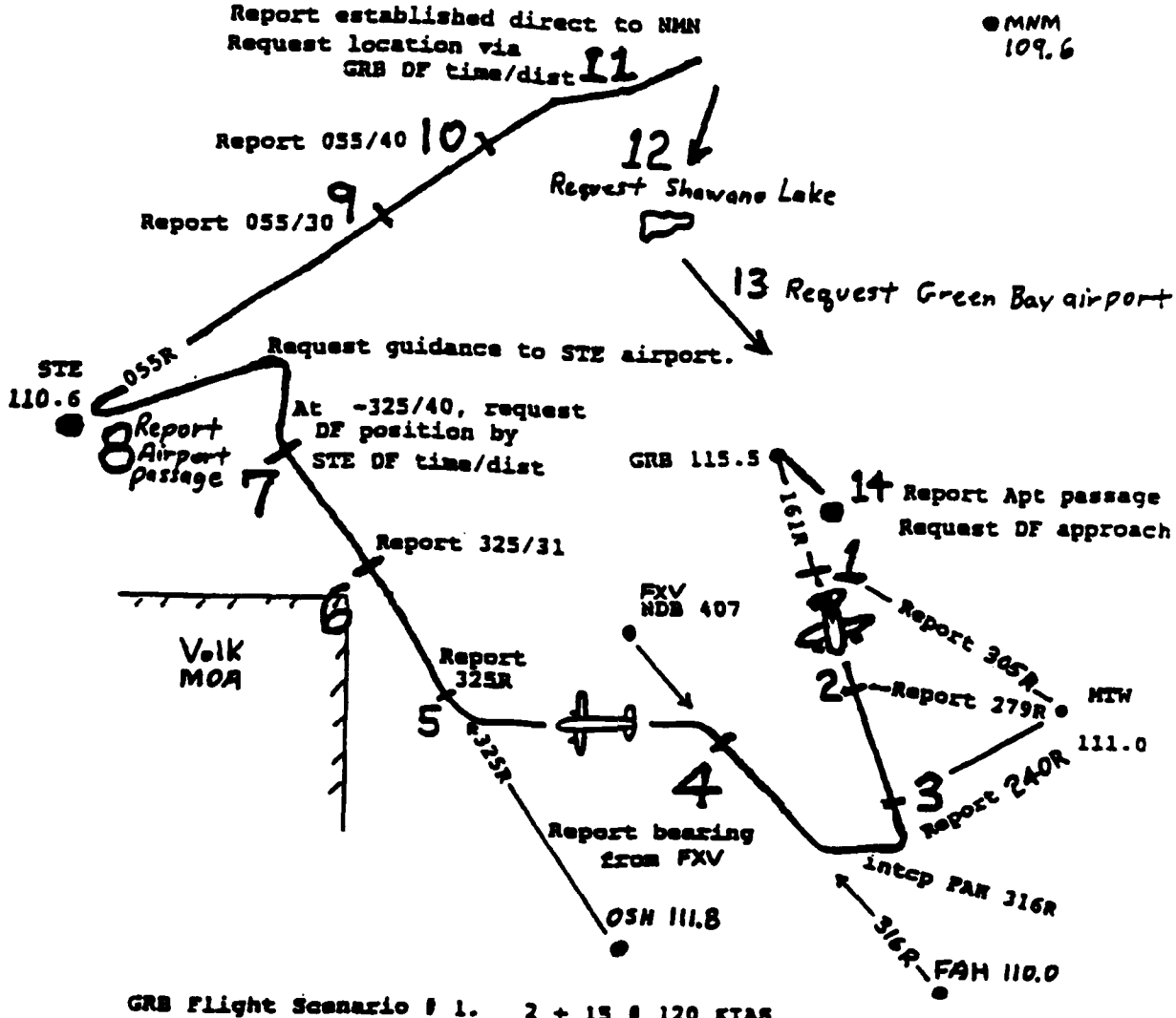
Discussion Items:

* IOT-2 Spurious characters - no longer present
* Implosion Protection on IDCU Display

Deviations/Discrepancies:

SECTION 3

PRELIMINARY OPERATIONAL TEST AND EVALUATION (OT&E) INTEGRATION AND OT&E OPERATIONAL TEST LOGS: MARCH 29 THROUGOH APRIL 9, 1993

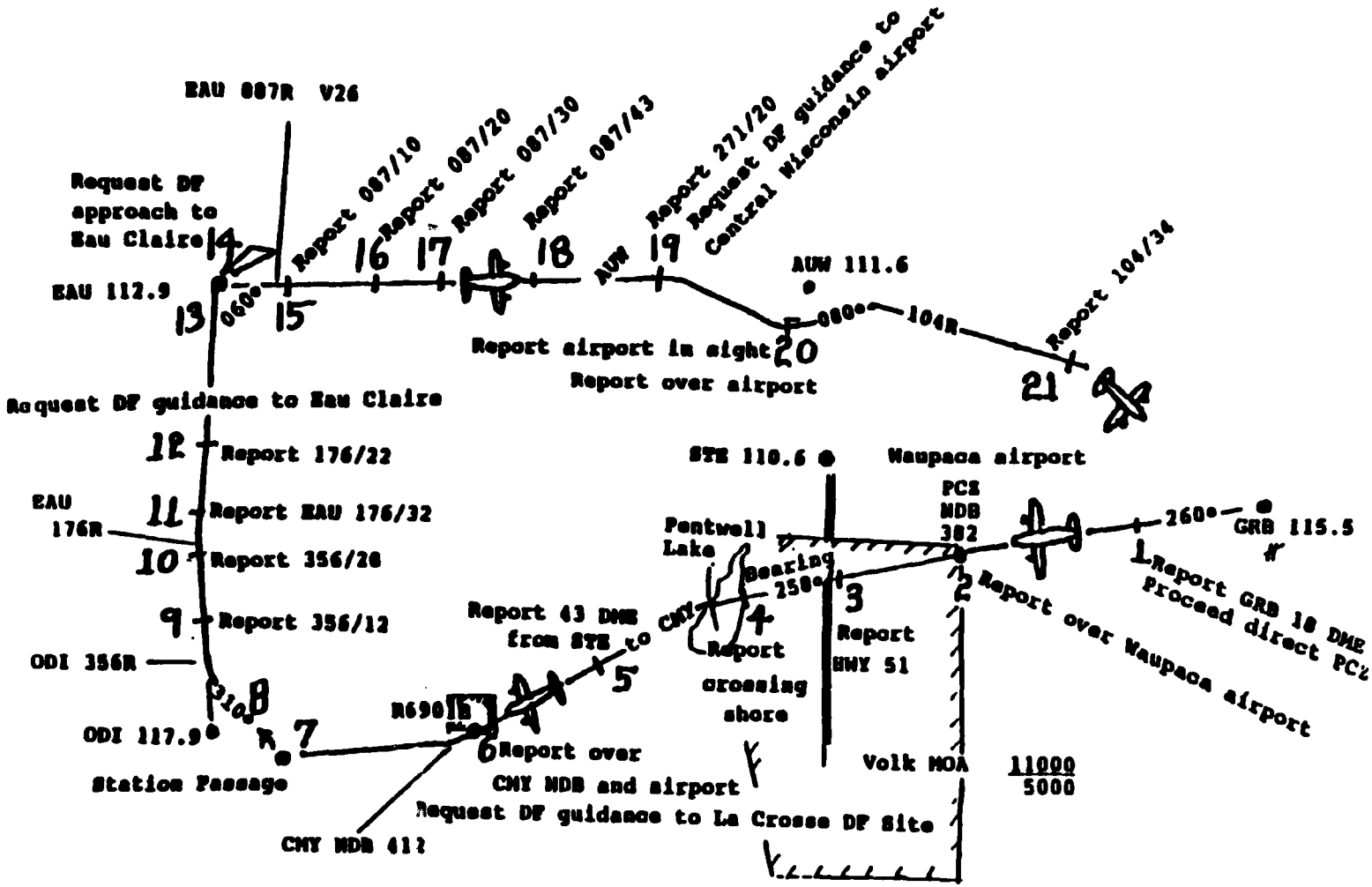


GRB Flight Scenario # 1. 2 + 15 @ 120 KIAS

DF freq 122.55, 123.6, Off Time 1826 Z Date 4/5/93

Pilot Theos McKinney Co Pilot —— Test Eng Ron Lockhart

In Flight WX VFR Scattered to broken clouds at 3,500 to 4,000'.



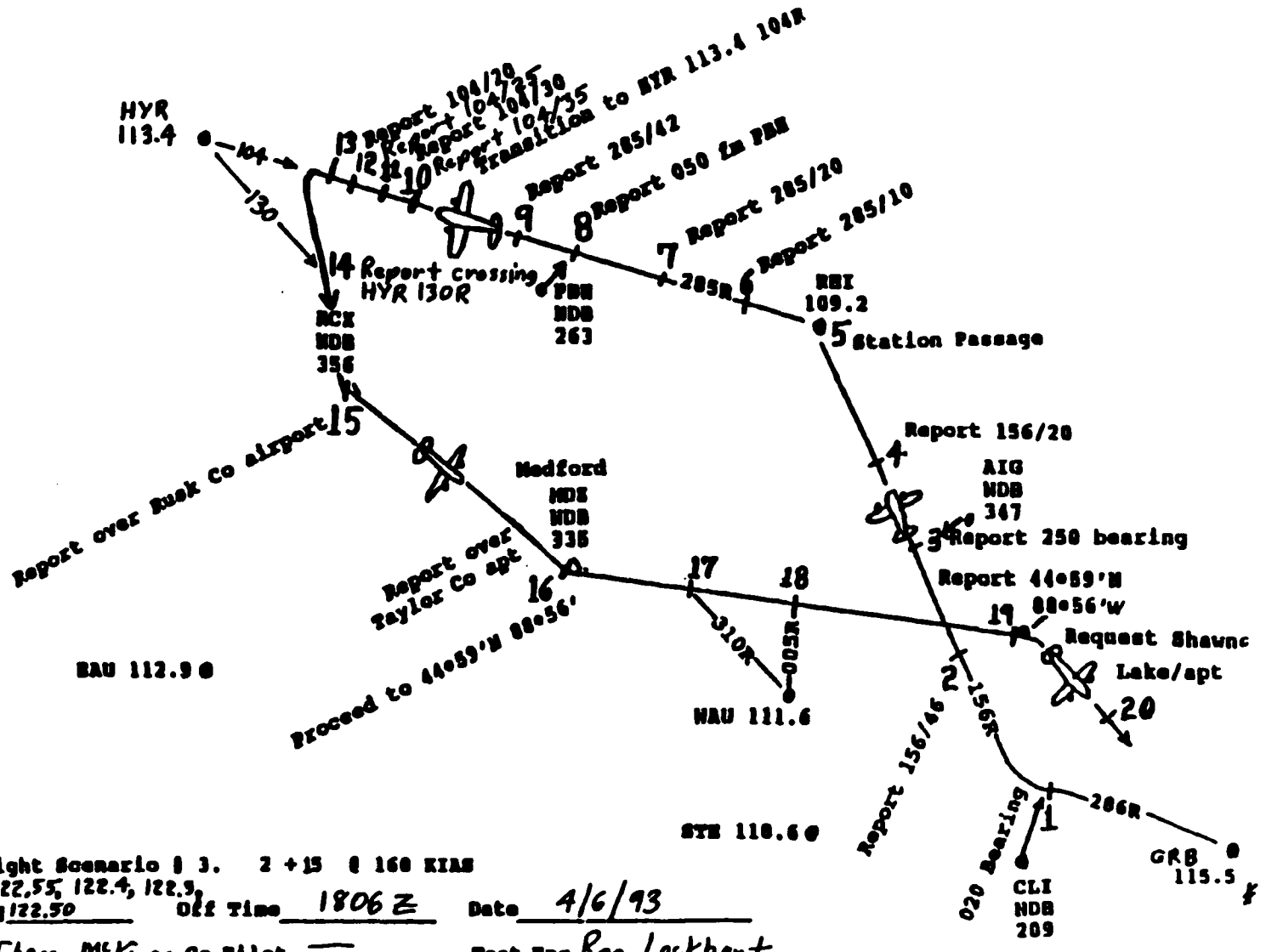
GRB Flight Scenario # 2. 2 + 45 @ 160 KIAS

DF freq 122.40, 122.50 (122.55, 122.35, 122.65) Off Time 1358Z Date 4/6/93

Pilot Theos McKinney Co Pilot ——— Test Eng Ron Lockhart

Clouds 3,500 To 6,000

In Flight WX 3 To 6 miles visibility, Time Down 1640Z

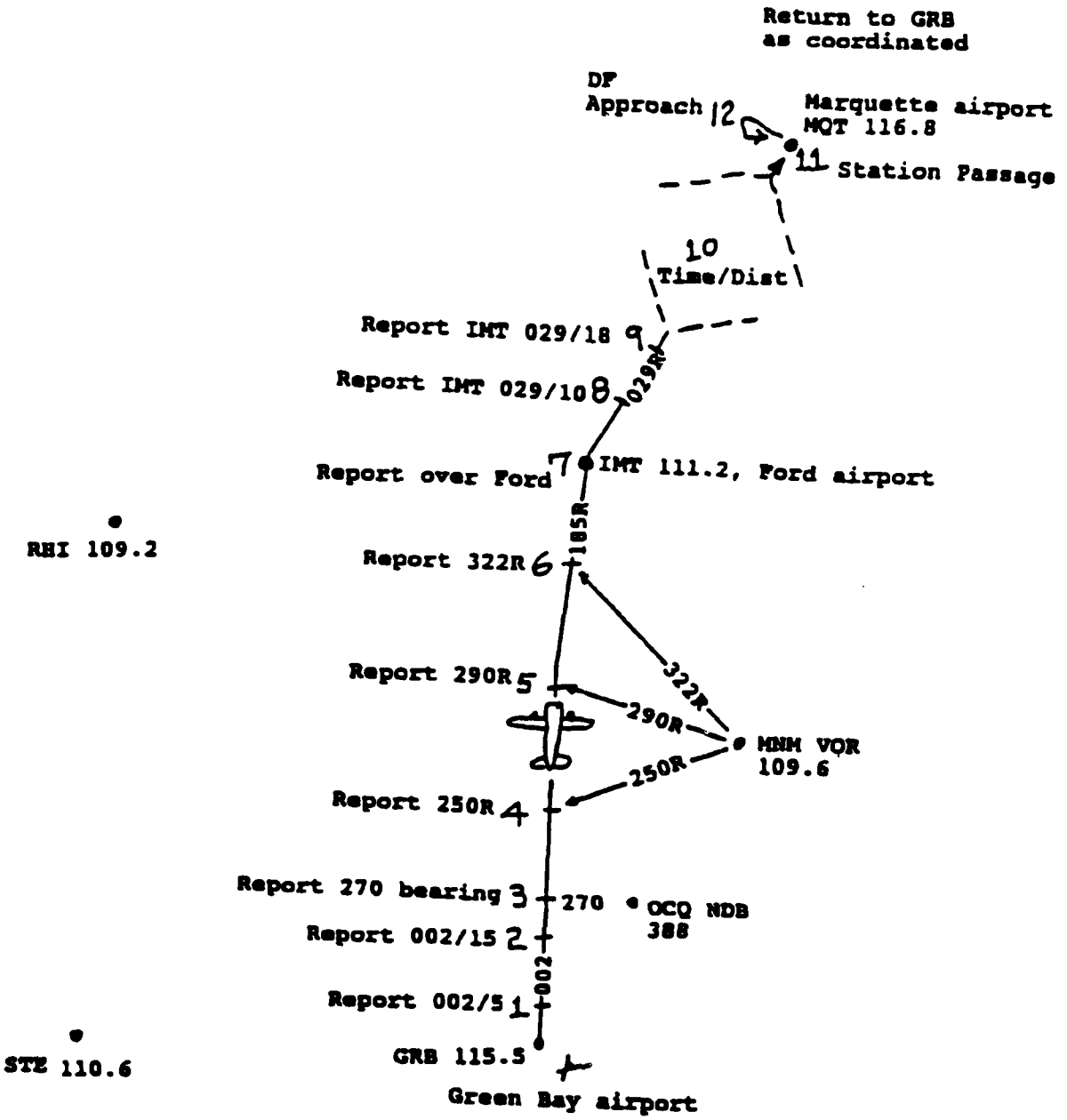


GRB Flight Scenario # 3. 2 +15 @ 160 KIAS

DF freq 122.50 (122.55, 122.4, 122.9) Off Time 1806 Z Date 4/6/93

Pilot Thos McKinney Co Pilot — Test Eng Ron Lockhart

In Flight WX 6 miles visibility Alt 3,500' Time Down 2026 Z

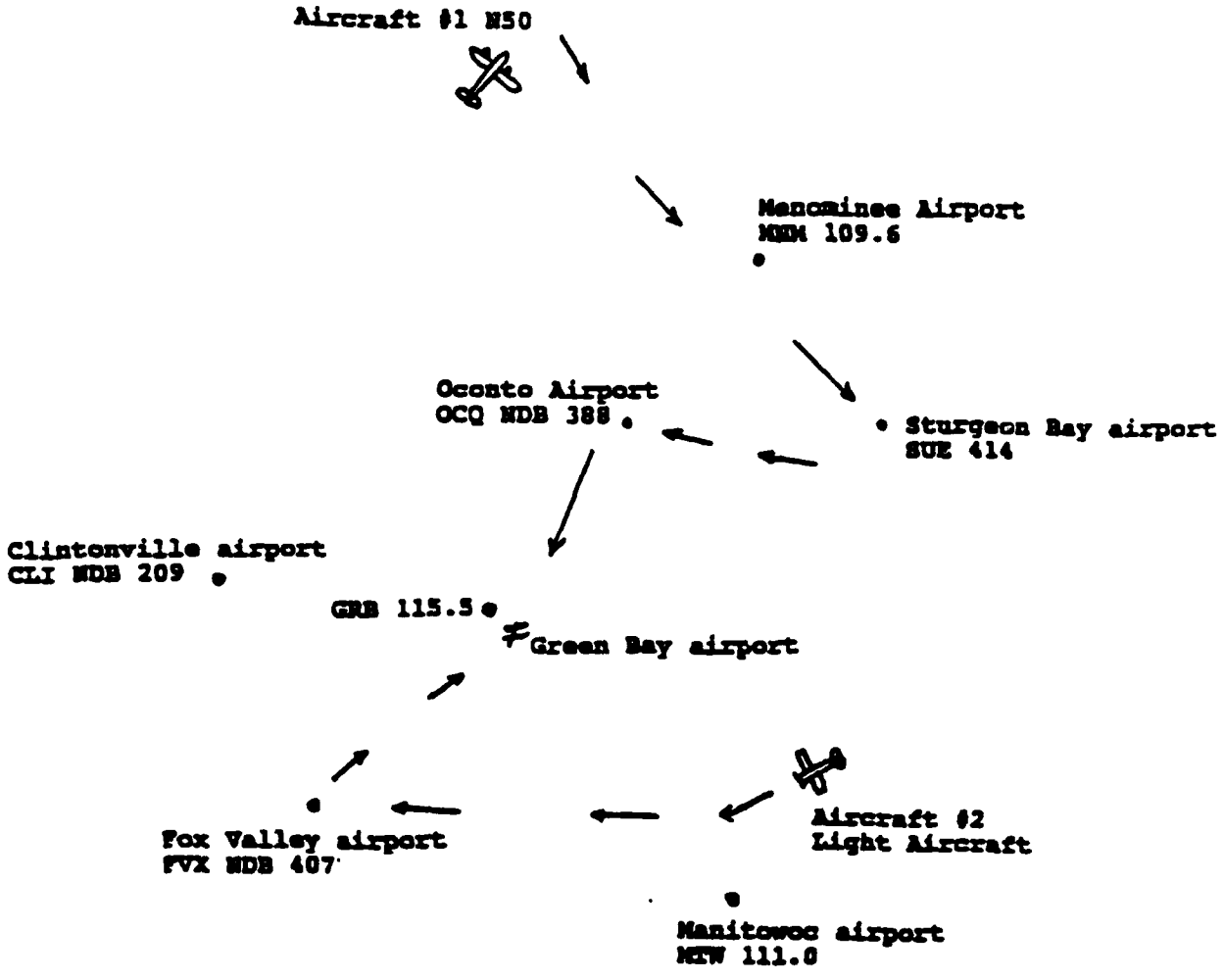


GRB Flight Scenario # 4. 2 + 30 @ 120 KIAS

DF freq 122.55, 122.1, 119.5 Off Time 1439 Z Date 4/7/93

Pilot Thaos McKinney Co Pilot ——— Test Eng Ron Lockhart

In Flight WX Clouds scattered + patchy 2,000' and up Visibility 3 to 6mi Alt 3,000 to 4500 Time Down 1705 Z



GRB Flight Scenario # 5. Two Aircraft. Approximately 45 minutes.

DF Freq 122.55, 127.2, Date 4/6/93

Aircraft #1 Pilot Theos McKinney Test Eng Ron Lockhart Off time 2139Z
AC 680E. Clouds 4000 broken
In flight WX 6mi visibility-Haze Alt 3500 Down time 2242 Z

Aircraft #2 Pilot Kelly LaPointe Test Eng John Dyson Off time 2150Z
Mavi XMIT-180 Clouds 4,000 broken-scattered
In flight WX 7miles visibility Alt 3500 to 3500 Down time 2230Z

VHF/DF OT&E
SCENARIO # 1 DRY RUN APRIL 3, 1993

Data collected by N50, GPS unit Latitude/Longitude.
Time is Z by GPS. 120 KIAS. 3,500 feet.

Event	Time	Latitude	Longitude	Comments
	1515	44 29.61	88 06.83	Apch End, RWY 24
1	1526	44 20.75	88 06.88	Time noted is a bit late
2	1529:50	44 09.87	88 03.01	DF may have received only a 2nd report a few seconds after this event #2 report
3	1534:15	43 59.81	87 59.21	
4	1541:10	43 58.65	88 09.17	
	1542:30	44 00.34	88 11.53	5" Tx req by DF
	1543:00	44 00.89	88 12.56	5" Tx req by DF
	1545:05	44 01.12	88 17.46	5" Tx req by DF
	1551:35	43 59.98	88 34.47	5" Tx req by DF
	1559:55			Tx by unkn aircraft
5	1600:25	44 13.05	88 43.34	
	1601:45	44 15.13	88 44.07	5" Tx req by DF
	1604:05	44 18.23	88 47.86	5" Tx req by DF
	1606:05	44 21.19	88 50.95	5" Tx req by DF
6	1609:10	44 25.36	88 55.79	
	1613:10	44 31.38	88 01.93	
7	1614:35	44 33.34	89 03.72	OSH 325R/40.7DME
8				Initial 240 heading to STE by DF was excellent. Still on DF 240 heading, N50 passed 3 nm SE of airport
	1637:25	44 37.43	89 21.29	5" Tx req by DF, ~STE 055/9
	1640:25	44 40.25	89 14.17	
9	1648:00	44 48.99	88 56.04	
10	1652:10	44 53.08	88 45.05	
	Continued with procedures as redlined.			
	1700:40	44 42.37	88 25.41	KGRB 318/19
	1702			N67F made numerous TX through 1704
	1704:05	44 37.05	88 18.07	KGRB 318/10.6
	1705:15	44 34.91	88 15.35	KGRB 318/7
	1706:40	44 32.41	88 12.33	

VHF/DF OT&E
SCENARIO # 1 DRY RUN APRIL 3, 1993

Data collected by N50, GPS unit Latitude/Longitude.
Time is Z by GPS. 120 KIAS. 3,500 feet.

Event Time	Latitude	Longitude	Comments
1707:50	44 30.42	88 09.87	
1708:35	44 29.09	88 08.05	
1709:55	44 27.99	88 06.38	KGRB 318
1709:55	44 26.99	88 04.70	KGRB 318
1720	44 29.06	88 08.01	Intx of 18/36 & 06/24 at KGRB

Ron Lockhart
Test Engineer, N50

VHF/DF OT&E
SCENARIO # 1 APRIL 5, 1993

Data collected by N50, GPS unit Latitude/Longitude.
Time is Z by GPS. 120 KIAS. 3,000 to 4,000 feet.

Event	Time	Latitude	Longitude	Comments
	1825	44 29.05	88 08.04	Intx of 18/36 & 06/24
1	1837:15	44 21.18	88 06.63	
2	1843:10	44 09.89	88 01.70	
3	1848:10	44 00.30	87 57.57	MTW 242R vice 240R
4	1001:20	44 09.17	88 25.89	
	1907:06	44 09.84	88 41.78	Bearing 240 fm FXV
5	1911:15	44 16.45	88 49.83	
6	1916:10	44 25.59	88 58.47	Coords taken ~1916:25
7	1920:45	44 33.06	89 05.47	DF guidance to STE
	1922:30	44 36.00	89 08.05	10" Tx requested by DF
	1925:35	44 40.18	89 13.77	10" Tx requested by DF
	1927:30	44 41.31	89 16.84	10" Tx requested by DF
				Airport at 1 O'clock, 7 nm
8	1934			Passed over SE boundary of
				STE airport on initial pass
Made DF approach to STE RWY 21, excellent alignment and heading.				
	1958:10	44 37.79	89 22.53	10" Tx requested by DF
	1959:00	44 37.98	89 29.66	10" Tx requested by DF
	2000:10	44 39.02	89 18.37	10" Tx requested by DF
9	2010:30	44 48.83	88 56.36	
10	2016:25	44 54.54	88 44.37	
	2018:10	44 55.97	88 40.76	10" Tx requested by DF
11				No data taken
	2024:15	44 59.07	88 26.41	5" past event #11
	2026:03	44 59.81	88 22.61	
	2028			Cherokee 45L on frequency
	2029:10	44 57.79	88 25.16	5" Tx requested by DF
12	2033			Sighted Shawano airport
				Passed 2 nm West of airport
	2036:58	44 47.27	88 33.94	Over Shawano airport

VHF/DF OT&E
SCENARIO # 1 APRIL 5, 1993

Data collected by N50, GPS unit Latitude/Longitude.
Time is Z by GPS. 120 KIAS. 3,000 to 4,000 feet.

Event	Time	Latitude	Longitude	Comments
13	2044:09	44 41.83	88 20.40	5" Tx requested by DF
	2046:05	44 41.67	88 15.93	5" Tx requested by DF
	2047:38	44 41.59	88 12.44	5" Tx requested by DF
	2025:55	44 37.08	88 10.11	
14	2054:30			DF heading 140 puts N50 over center of GRB airport
	2103:15			DF heading 065 puts RWY 06 at N50's 12 O'clock
	2104:35			2 1/2 nm from RWY threshold DF heading remains 065, RWY is still 12 O'clock.
	2108	44 29.09	88 08.02	Intx of 18/36 & 06/24

Ron Lockhart
Test Engineer, N50

VHF/DF OT&E
SCENARIO # 2 APRIL 6, 1993

Data collected by N50, GPS unit Latitude/Longitude.
Time is Z by GPS. 160 KIAS. 3,000 to 3,500 feet.

Event	Time	Latitude	Longitude	Comments
	1358	44 29.58	88 06.77	Apch end RWY 24
1	1408:25	44 36.72	88 38.31	This is 19 vice 18 DME
2				No data collected
	1419:34	44 19.41	88 01.39	5" Tx req by DF about 5" after event 2.
3	1428:30	44 12.75	88 31.44	Radio problems, DF missed?
4	1437:30	44 05.23	90 01.87	West, vice east, shore of Pentwell Lake
5	1441:20	44 01:95	90 14.63	#5, not DF req Tx 5" later
6	1452:10	43 55.63	90 38.50	Approx 1 nm S of CMY NDB
	1444:35	43 59.09	90 26.03	5" Tx req by DF
	1456:10	43 54.33	90 52.66	5" Tx req by DF
7				N50 unable to visually ID the DF antenna site. Using landmarks, estimate passing within 1/2 nm of DF site.
8				Data collection not req.
9	1511:05	44 07.49	91 28.32	
10	1514:05	44 15.38	91 27.64	
11	1516:25	44 22.20	91 27.77	#11. not DF req Tx 5" later
12	1520:20	44 32.19	91 28.25	
13				1st pass over EAU airport 1/4 nm S of center.
14				DF approach & final alignment to EAU RWY 22 was excellent.
15	1543:25	44 54.12	91 13.41	
16	1547:05	44 54.70	90 59.86	#16, not DF req Tx 5" later
17	1551:01	44 55.12	90 46.08	

VHF/DF OT&E
SCENARIO # 2 APRIL 6, 1993

Data collected by N50, GPS unit Latitude/Longitude.
Time is Z by GPS. 160 KIAS. 3,000 to 3,500 feet.

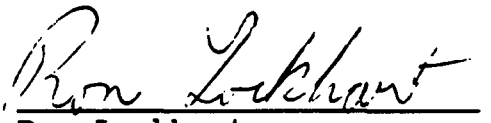
Event	Time	Latitude	Longitude	Comments
18				No data collected
	1556:40	44 54.78	90 26.04	DF req 10" TX about 5" past event 18.
19	1603:30	44 51.79	90 02.77	Not DF req Tx at 1603:40
	1604:40	44 51.61	89 58.59	DF req 5" Tx
	1609:10			DF heading 130 to Central WI aiport is excellent
20	1610:30	44 46.80	89 39.81	Over Central WI airport, still on DF 130 heading
	1613			Numerous Tx by ukn aircraft at Dodge Co airport
	1615			DF guidance to GRB starts.
	1620			DF req bearing to PCZ NDB, N50 provides 166
	1628			Scenario terminated, DF system failure due to RMMC testing.
	1640	44 29.56	88 06.80	Apch end RWY 24

Ron Lockhart
Test Engineer, N50

VHF/DF OT&E
SCENARIO # 3 APRIL 6, 1993

Data collected by N50, GPS unit Latitude/Longitude.
Time is Z by GPS. 160 KIAS. 3,500 feet.

Event	Time	Latitude	Longitude	Comments
1	1823:40	44 39.55	88 43.20	
2	1832:08	44 56.85	88 59.35	
3	1837:30	45 09.14	89 09.13	
4	1842:35	45 20.90	89 16.54	This is 156/19 vice 156/20
5	1949:45	45 38.09	89 27.58	Overhead RHI airport, slightly NW of center
6	1853:45	45 41.55	89 41.51	
7	1857:40	45 44.14	89 55.43	Bearing 087 from PBH
8	1903:10	45 48.37	90 14.71	
9	1906:50	45 50.92	90 28.33	This is 285/44 vice 285/42
10				No data recorded
11	1911:50	45 52.81	90 46.07	
12	1914:15	45 53.47	90 54.78	This is 104/24 vice 104/25
13	1916:05	45 54.58	91 10.57	This is 104/19 vice 104/20
14	1921:40	45 45.37	91 05.33	Radial 130 off HYR is rough
15	1928:01	45 30.02	91 00.21	Over Rusk Co airport
	1932:15	45 23.77	90 48.64	10" Tx req by DF
	1933:40	45 21.73	90 44.77	10" Tx req by DF
	1937:50	45 14.20	90 33.27	10" Tx req by DF
16				Missed, no radio contact
17	1949:59	45 03.97	89 53.18	Reported the WAU 337R
18	1956:05	45 01.91	89 30.21	This is WAU 010R, vice 005R
19	2104			Scenario terminated by DF



Ron Lockhart
Test Engineer, N50

VHF/DF OT&E
SCENARIO # 4 APRIL 7, 1993

Data collected by N50, GPS unit Latitude/Longitude.
Time is Z by GPS. 120 KIAS. 3,000 to 4,500 feet.

Event	Time	Latitude	Longitude	Comments
1	1445:50	44 38.53	88 11.34	
2	1449:50	44 48.64	88 10.22	
3	1451:45	44 52.46	88 09.95	
4	1457:40	45 04.04	88 09.60	
5	1505:25	45 19.88	88 08.19	DF missed, radio problems
6	1514:10	45 37.10	88 06.97	
7	1520:10	45 48.94	88 06.84	Over Ford airport
8	1527:30	46 02.47	87 57.42	This is 029/15 vice 029/10
9	1529:15	46 05.45	87 54.38	
10				Time/Dist location by DF
	1535			DF says N50 is 17 nm from MQT, N50's DME is 24 nm
11	1546:30			First pass to MQT was over airport, SW boundary.
12				DF approach to MQT airport

DF guidance on heading 045 took N50 about 7 nm to north east, farther than necessary. (In debriefing, operator notes that two aircraft were being worked at the same time. He had forgotten to make N50 the selected Aircraft, and therefore did not get updated bearing information on N50). The remainder of the approach went normally.

	1600			DF heading 080 puts N50 on course about 50 meters to left side of the RWY. Call to descend was late, given just prior to RWY threshold

VHF/DF OT&E
SCENARIO # 4 APRIL 7, 1993

Data collected by N50, GPS unit Latitude/Longitude.
Time is Z by GPS. 120 KIAS. 3,000 to 4,500 feet.

Event Time	Latitude	Longitude	Comments

In debriefing, the operator noted that he realized the call was late and should have been given earlier.

After completion of the scenario, N50 worked with Green Bay approach control to do test events requested by Mr. Bill Fish. They are intended to demonstrate the ability of the DF to locate an aircraft at the request of a radar control facility on their frequencies. In this case, 119.5, Green Bay approach control was used.

1640:40	45 08.68	88 09.16	MNM VOR Radial 261
1643	45 02.60	88 09.53	MNM VOR Radial 249
1646:30	44 54.89	88 09.49	MNM VOR Radial 232

Ron Lockhart
Test Engineer, N50

VHF/DF OT&E
SCENARIO # 5 TWO AIRCRAFT APRIL 6, 1993

Data collected by N50, GPS unit Latitude/Longitude.
Time is Z by GPS. 120 KIAS. 3,500 feet.

N50 is considered Aircraft Number 1 in the scenario. Aircraft Number 2 is a light aircraft, call sign Maul 28L.

Event Time	Latitude	Longitude	Comments
2139	44 29.62	88 08.02	Apch end RWY 18 DF guidance to Menominee
2155:45	44 58.64	88 00.77	5" Tx req by DF Another aircraft was heard on frequency
2157:03	44 59.14	87 56.37	5" Tx req by DF
2200			DF says N50 is 7 nm SW of Menominee, N50 concurs.
DF guidance to Sturgeon Bay			
2205			DF heading 165 to Sturgeon Bay airport is very good
2207:10	45 00.58	87 29.76	
2209:30			DF says N50 is 12 nm from Sturgeon Bay. GPS dist is 6.4 nm
	44 51.19	87 25.60	165 heading puts N50 over Sturgeon Bay airport. DF calls N50 4 nm N of Sturgeon Bay, N50 is over northern end of airport
DF guidance to Oconto			
2215:35	44 47.96	87 29.60	5" Tx req by DF
2218:10			DF says N50 is 18 nm E of Oconto. GPS dist is 13 E.
2223:01			DF says N50 is 6 nm SE of Oconto. GPS agrees.
2225:00	44 49.95	87 55.45	N50 passes 2 1/2 nm SW of Oconto
2232			Scenario terminated for both aircraft.

Ron Lockhart
Test Engineer, N50

SECTION 4

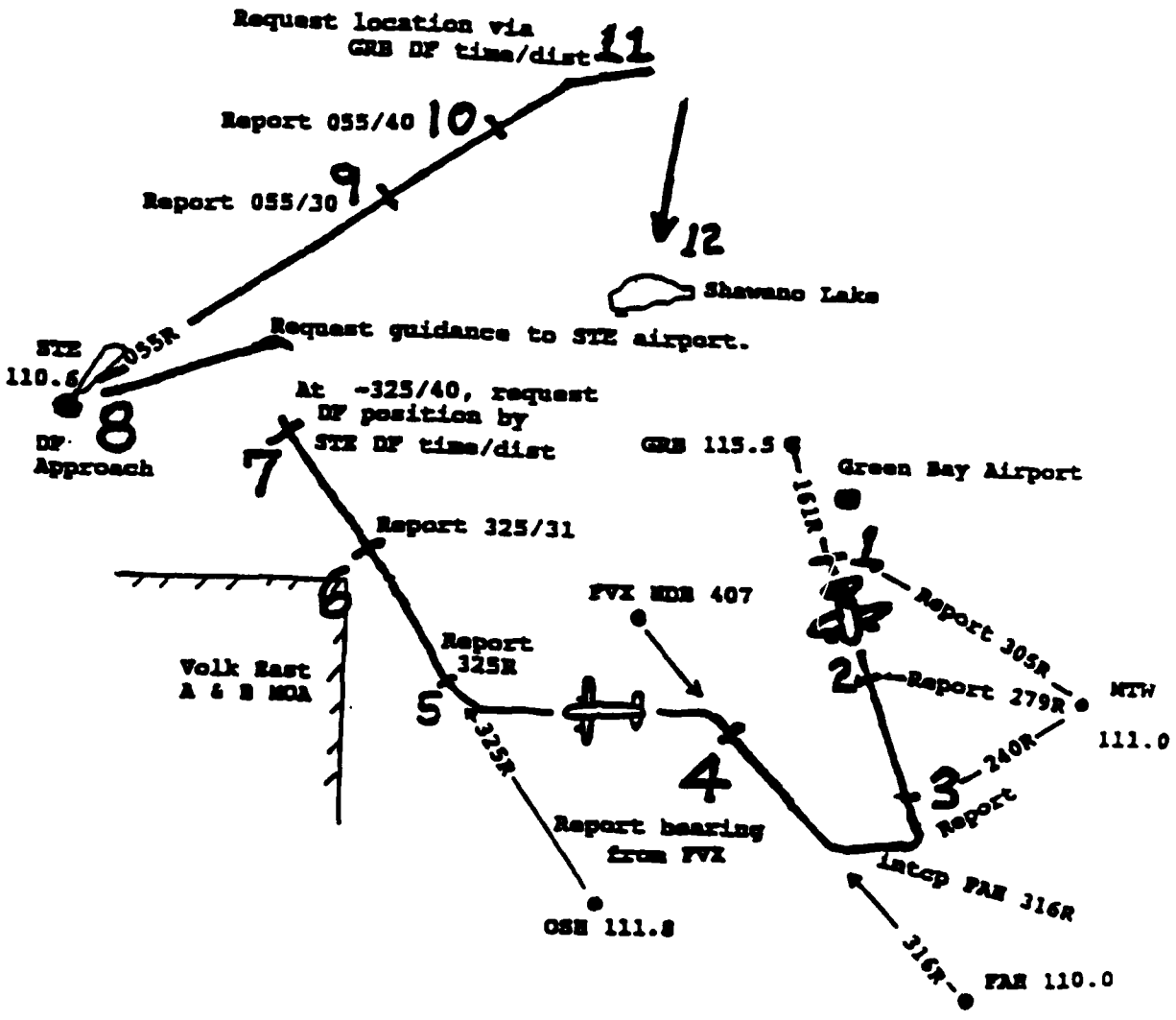
OPERATIONAL TEST AND EVALUATION (OT&E) INTEGRATION AND OT&E OPERATIONAL TEST LOGS: JUNE 21 THROUGH JUNE 24, 1993

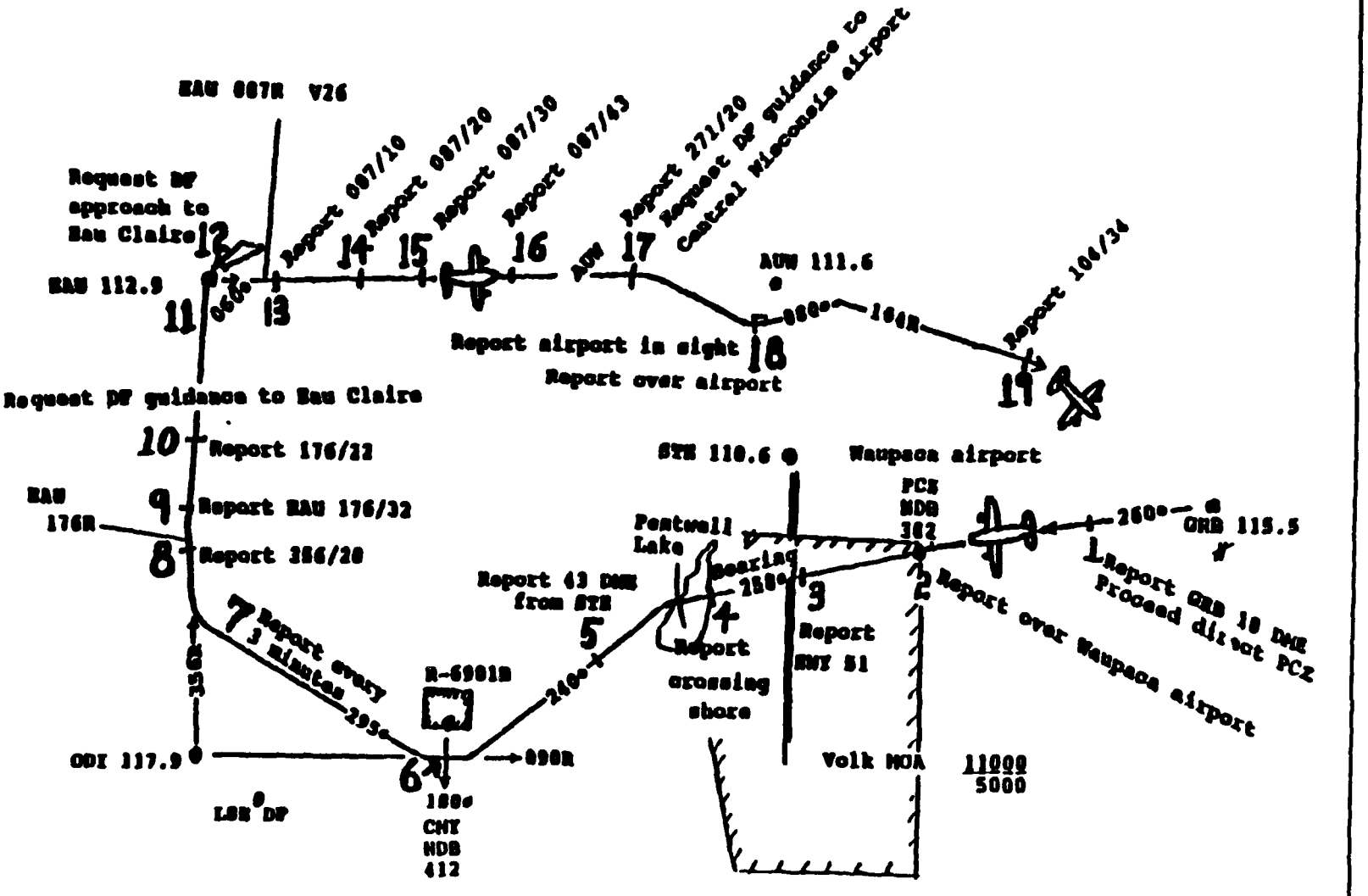
GRB Flight Scenario # 1. 2 + 15 @ 120 KIAS

DF freq 122.55, 123.6 Off Time 1947Z Date 6/21/93

Pilot Theos McKinney Co Pilot —— Test Eng Ron Lockhart

In Flight Wx Clear, 15 miles visibility





ORB Flight Scenario # 2. 2 + 45 @ 160 KIAS
122.55, 123.6, 122.55, 122.35
DF freq 122.65, 122.4 Off Time 1403 Z Date 6/22/93

Pilot Theos McKinney Co Pilot —— Test Eng Ron Lockhart

VHF/DF OT&E Green Bay AFSS WI
Flight Scenario # 1
June 21, 1993

Data collected onboard N50, FAA Technical Center Aero Commander. GPS unit Latitude/Longitude, and time in Z. 120 KIAS. 3,500 to 4,500 feet. Green Bay AFSS frequency 122.55. Time hack at 2023:24 between GPS unit and DF operator was within 1 second. GPS positions recorded here are at the end of the transmission by N50 announcing the event point.

Event	Time	Latitude	Longitude	Comments
	1939	44 29.50	88 07.72	Executive Air Ramp
1		44 20.26	88 05.33	
2		44 09.42	88 00.42	
3		44 00.81	87 56.43	
		44 03.38	87 57.65	5" Xmt
4		44 03.55	88 16.29	
	2012:30	44 04.07	88 21.70	10" Xmt
	2013:09	44 03.83	88 23.28	10" Xmt
	2014:15	44 03.26	88 27.11	10" Xmt
5	2020:00	44 06.30	88 39.65	
	2029:30	44 22.03	88 54.27	
6	2031:30	44 25.82	88 57.81	
	2032:50	44 27.70	88 59.51	5" Xmt
	2034:10	44 30.03	89 01.67	5" Xmt
7	2037:45	44 36.87	89 04.70	Requested DF position by Time/Distance calculation and guidance to STE airport. DF heading given was 255°. At 15nm from STE GPS showed 253°. At 10nm GPS showed 256°.
	2028:40			N50 passed 1/2 mile south of STE RWY 3 on 255°.
8				DF approach to STE RWY 21 N50 crossed RWY 21 extended centerline, on DF heading 200° about 1/4 mile from threshold.
	2100			Several garbled Xmts heard on 122.55 by N50.
	2105:50	44 35.45	89 25.37	5" Xmt
	2108:35	44 39.78	89 17.03	5" Xmt
	2113:15	44 47.06	89 01.86	5" Xmt

VHF/DF OT&E Green Bay AFSS WI
Flight Scenario # 1
June 21, 1993

Data collected onboard N50, FAA Technical Center Aero Commander. GPS unit Latitude/Longitude, and time in Z. 120 KIAS. 3,500 to 4,500 feet. Green Bay AFSS frequency 122.55. Time hack at 2023:24 between GPS unit and DF operator was within 1 second. GPS positions recorded here are at the end of the transmission by N50 announcing the event point.

Event	Time	Latitude	Longitude	Comments
9	2115:17	44 49.94	88 56.34	
10	2119:40	44 55.54	88 44.88	
11	2124:10	44 50.64	88 35.23	5" Xmt
12				N50 Requested guidance to Shawano Lake. DF correctly advised N50 that Lake should be close and straight ahead.
	2128			Added DF position location by Time/Distance calculation. DF called N50 20 nm north west of Green Bay airport, GPS showed 12 nm.
	2148	44 29.57	88 07.79	Executive Air Ramp, a few hundred feet from starting point

Ron Lockhart
Test Engineer, N50

VHF/DF OT&E Green Bay AFSS WI
Flight Scenario # 2
June 22, 1993

Data collected onboard N50, FAA Technical Center Aero Commander. GPS unit Latitude/Longitude, and time in Z. 155 KIAS. 3,500 to 4,500 feet. Green Bay AFSS frequencies 122.55, 123.6, 122.5, 122.35, 122.65, and 122.4. GPS positions recorded here are at the end of the transmission by N50 announcing the event point.

Event	Time	Latitude	Longitude	Comments
	1352	44 29.56	88 07.81	Executive Air Ramp
1	1415:30	44 29.41	88 37.21	
2	1422:40	44 20.07	89 00.90	
	1428:30	44 14.52	89 20.39	5" Xmt
3	1431:40	44 13.13	89 31.57	253° bearing from PCZ
	1435:10	44 12.30	89 44.70	5" Xmt
4	1437:25	44 11.04	89 53.08	East shore Pentwell Lake
	1439:50	44 07.59	90 00.52	5" Xmt
5	1446:10	43 55.76	90 14.39	STE 205/47
	1447:50	43 54.94	90 20.58	5" Xmt
6	1452:45	43 55.80	90 39.17	190° vice 180° from CMY
	1453:20	43 55.85	90 41.61	5" Xmt
7	1457:10	43 59.04	90 55.49	Report by N50, ODI 074/54
	1500:10	44 02.16	91 05.98	Report by N50, ODI 060/17.5
	1503:05	44 04.94	91 15.79	Report by N50, ODI 036/13
	1505:10	44 07.05	91 23.11	5" Xmt
8	1511:50	44 21.55	91 26.75	EAU 356/26, & ONA 030
9				Missed
	1516			Other AC on frequency
10	1517:15	44 36.76	91 29.78	EAU 176/18, & ONA 015
11	1519			DF Guidance to EAU airport. DF heading 360° put N50 directly over airport.
12				DF approach to EAU RWY 22 DF heading 225° on final approach leg put N50 parallel & about 1nm east of RWY. Last DF heading 240° on final approach of put N50 across intx of RWYs at EAU.

VHF/DF OT&E Green Bay AFSS WI
Flight Scenario # 2
June 22, 1993

Data collected onboard N50, FAA Technical Center Aero Commander. GPS unit Latitude/Longitude, and time in Z. 155 KIAS. 3,500 to 4,500 feet. Green Bay AFSS frequencies 122.55, 123.6, 122.5, 122.35, 122.65, and 122.4. GPS positions recorded here are at the end of the transmission by N50 announcing the event point.

Event	Time	Latitude	Longitude	Comments
13	1544:15	44 53.47	91 14.00	
	1545:05	44 53.23	91 11.03	10" Xmt
	1546:10	44 53 21	91 07 37	5" Xmt
14	1548:05	44 53:99	91 00.19	
	1558:05			Another AC of frequency
15	1559:45	45 01.99	90 43.46	EAU 069/34, Time/Distance
	1602:00	44 57.12	90 36.19	5" Xmt
16	1604:25	44 55.59	90 27.73	
	1608:35	44 53.24	90 13.32	5" Xmt
17	1611:30	44 51.51	90 02.97	
18				DF provided headings of 105°, then 115°, then 125° to Central WI airport. The 115° would have put N50 directly over airport. On 125° N50 passed 2nm southwest of airport.
	1622:30	44 44:40	89 24.77	5" Xmt
	1624:40	44 45.12	89 16.55	5" Xmt
	1625:50	44 45.32	89 12.10	5" Xmt & AUW 105/17
	1627:20	44 45.01	89 06.64	5" Xmt
	1629:20	44 43.23	88 59.81	5" Xmt
	1629:50	44 42.29	88 58.12	5" Xmt
	1632			AC, GlasAire on freq.
19	1633:20	44 40.63	88 45.34	AUW 104/36

Ron Lockhart

Ron Lockhart

SECTION 5

CORRELATED POSITION DATA SPREAD SHEETS PRELIMINARY AND FORMAL OT&E

VDF Formal Operational Test and Evaluation Scenario #1 Results

EVENT	TIME (HMS)	GPS LAT LONG (DMIN)	GRB AZIM. (DEGRS)	GRB RANGE (NM)	STE AZIM. (DEGRS)	STE RANGE (NM)	IDCU1 GRB AZIM. (DEGRS)	IDCU1 STE AZIM. (DEGRS)	IDCU1 LAT. LONG. (DMS)	GPS LAT LONG (DEGRS)	GRB ERROR (DEGRS)	STE ERROR (DEGRS)
1		4420.26	169.9	9.5	101.1	63.1	174		441832	44.33767	4	
		8805.33							880508	88.08883		
2		4409.42	164.6	20.8	109.4	69.5		111	440923	44.15700		2
		8800.42							875902	88.00700		
3		4400.81	163.1	29.9	114.8	75.5	167		440004	44.01350	4	
		8756.43							875606	87.94050		
		4403.38	163.5	27.2	113.3	73.6				44.05633		
		8757.65								87.96083		
4		4403.55	192.2	26.9	118.2	61.5	194	116	440359	44.05917	2	-2
		8816.29							881445	88.27150		
	201230	4404.07	200.4	27.6	119.5	57.8	203	101	442036	44.06783	3	-19
		8821.7							881201	88.36167		
	201309	4403.83	202.3	28.3	120.3	57.0	205	112	441011	44.06383	3	-8
		8823.28							881841	88.38800		
	201415	4403.26	206.7	30.0	122.3	54.9	209	121	440254	44.05433	2	-1
		8827.11							882535	88.45183		
5	202000	4406.3	223.2	33.0	125.2	45.7	229	126	440558	44.10500	6	1
		8839.65							884241	88.66083		
	202930	4422.03	255.7	34.5	111.5	28.9	261	114	442205	44.36717	5	3
		8854.27							885937	88.90450		
6	203130	4425.82	262.5	36.4	105.5	25.3	268	107	442627	44.43033	6	1
		8857.81							890526	88.96350		
	203250	4427.7	265.6	37.4	101.9	23.6	269	103		44.46167	3	1
		8859.51								88.99183		
	203410	4430.03	269.1	38.9	96.7	21.7		98		44.50050		1
		8901.67								89.02783		
7	203745	4436.87	278.6	41.7	77.5	19.9		79		44.61450		2
		8904.7								89.07833		
8			89.5	3443.1	90.8	3443.9						

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

VDF Formal Operational Test and Evaluation Scenario #1 Results

EVENT	TIME (HMS)	GPS LAT LONG (DMIN)	GRB AZIM. (DEGRS)	GRB RANGE (NM)	STE AZIM. (DEGRS)	STE RANGE (NM)	IDCU1 GRB AZIM. (DEGRS)	IDCU1 STE AZIM. (DEGRS)	IDCU1 LAT. LONG. (DMS)	GPS LAT LONG (DEGRS)	GRB ERROR (DEGRS)	STE ERROR (DEGRS)
	210550	4435.45	274.6	56.1	57.7	5.6	276	59	443347	44.59083	1	1
		8925.37							892847	89.42283		
	210835	4439.78	280.2	50.8	55.7	12.9	280	55	443646	44.66300	0	-1
		8917.03							892309	89.28383		
	211315	4447.06	292.7	42.7	56.0	25.9	294	58	444504	44.78433	1	2
		8901.86							890244	89.03100		
9	211517	4449.94	298.7	40.5	55.6	30.8	304	54	445045	44.83233	5	-2
		8856.34							885553	88.93900		
10	211940	4455.54	312.5	37.3	55.6	40.7	315	58	445306	44.92567	2	2
		8844.88							884259	88.74800		
11	212410	4450.64	314.9	29.0	65.9	44.3	317	67	444904	44.84400	2	1
		8835.23							883431	88.58717		

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

VDF Formal Operational Test and Evaluation Scenario #2 Results (GRB and STE)

EVENT	TIME	GPS LAT LONG	GRB AZIM.	GRB RANGE	STE AZIM.	STE RANGE	IDCU1 GRB AZIM.	IDCU1 STE AZIM.	IDCU1 LAT. LONG.	GPS LAT LONG	GRB ERROR	STE ERROR
	(HMS)	(DMIN)	(DEGRS)	(NM)	(DEGRS)	(NM)	(DEGRS)	(DEGRS)	(DMS)	(DEGRS)	(DEGRS)	(DEGRS)
1	141530	4429.41	267.8	21.4	96.6	39.2	271	96		44.49017	3	1
		8837.21								88.62017		
2	142240	4420.07	254.5	39.6	119.5	25.4	257	120	441927	44.33450	2	0
		8900.9							890142	89.01500		
	142830	4414.52	252.5	54.5	155.8	19.8	269	156	441737	44.24200	16	0
		8920.39							892253	89.33983		
3	143140	4413.13	253.4	62.6	179.8	19.4	255	181	440959	44.21883	2	1
		8931.57							893244	89.52617		
	143510	4412.3	254.8	71.9	205.0	22.2				44.20500		
		8944.7								89.74500		
4	143725	4411.04	255.0	78.1	215.9	26.3		217		44.18400		1
		8953.08								89.88467		
	143950	4407.59	253.7	84.1	220.1	32.3		222		44.12650		2
		9000.52								90.00867		
5	144610	4355.76	248.6	97.4	220.4	47.8		220	440309	43.92933		0
		9014.39							900709	90.23983		
	144750	4354.94	249.0	101.9	223.7	51.3		224	435632	43.91567		0
		9020.58							902057	90.34300		
6	145245	4355.8	251.8	114.2	233.6	60.6				43.93000		
		9039.17								90.65283		
	145320	4355.85	252.1	115.9	234.7	62.0		234		43.93083		-1
		9041.61								90.69350		
7	145710	4359.04	254.9	124.6	241.8	68.7			440044	43.98400		
		9055.49							905215	90.92483		
	150010	4402.16	257.1	131.1	246.8	74.0			435907	44.03600		
		9105.98							910748	91.09967		
	150305	4404.94	258.9	137.4	250.8	79.4				44.08233		
		9115.79								91.26317		
	150510	4407.05	260.2	142.2	253.4	83.6				44.11750		
		9123.11								91.38517		

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

VDF Formal Operational Test and Evaluation Scenario #2 Results (GRB and STE)

EVENT	TIME (HMS)	GPS LAT LONG (DMIN)	GRB AZIM. (DEGRS)	GRB RANGE (NM)	STE AZIM. (DEGRS)	STE RANGE (NM)	IDCU1 GRB AZIM. (DEGRS)	IDCU1 STE AZIM. (DEGRS)	IDCU1 LAT. LONG. (DMS)	GPS LAT LONG (DEGRS)	GRB ERROR (DEGRS)	STE ERROR (DEGRS)
8	151150	4421.55 9126.75	266.1	142.9	263.6	82.8				44.35917 91.44583		
10	151715	4436.76 9129.78	272.2	144.7	274.1	84.2				44.61267 91.49633		
13	154415	4453.47 9114	279.5	135.1	287.3	75.7				44.89117 91.23333		

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

VDF Formal Operational Test and Evaluation Scenario #2 Results (EAU and LSE)

EVENT	TIME (HMS)	GPS LAT LONG (DMIN)	LSE AZIM. (DEGRS)	LSE RANGE (NM)	EAU AZIM. (DEGRS)	EAU RANGE (NM)	IDCU1 LSE AZIM. (DEGRS)	IDCU1 EAU AZIM. (DEGRS)	IDCU1 LAT. LONG. (DMS)	GPS LAT LONG (DEGRS)	LSE ERROR (DEGRS)	EAU ERROR (DEGRS)
1	141530	4429.41								44.49017		
		8837.21	69.4	118.4	101.5	124.6				88.62017		
2	142240	4420.07							441927	44.33450		
		8900.9	71.3	99.4	107.9	110.5			890142	89.01500		
	142830	4414.52							441737	44.24200		
		8920.39	72.1	84.4	113.4	99.4			892253	89.33983		
3	143140	4413.13							440959	44.21883		
		8931.57	71.3	76.3	116.2	92.6			893244	89.52617		
	143510	4412.3								44.20500		
		8944.7	69.6	67.1	119.4	84.6				89.74500		
4	143725	4411.04								44.18400		
		8953.08	68.8	61.0	122.3	80.0				89.88467		
	143950	4407.59								44.12650		
		9000.52	70.2	54.8	126.5	77.5				90.00867		
5	144610	4355.76							440309	43.92933		
		9014.39	81.1	42.3	138.0	77.8	73		900709	90.23983	-8	
	144750	4354.94							435632	43.91567		
		9020.58	81.3	37.7	140.9	75.4	79		902057	90.34300	-2	
6	145245	4355.8								43.93000		
		9039.17	74.9	24.7	149.2	66.8	76			90.65283	1	
	145320	4355.85								43.93083		
		9041.61	73.7	23.0	150.5	65.8	72			90.69350	-2	
7	145710	4359.04							440044	43.98400		
		9055.49	51.5	15.4	157.3	58.3	52	150	905215	90.92483	0	-7
	150010	4402.16							435907	44.03600		
		9105.98	19.6	13.5	163.4	52.6	18	162	910748	91.09967	-2	-1
	150305	4404.94								44.08233		
		9115.79	350.7	15.7	170.4	48.1	350	167		91.26317	-1	-3
	150510	4407.05								44.11750		
		9123.11	336.1	19.3	176.4	45.2	333	171		91.38517	-3	-5
EVENT	TIME	GPS LAT	LSE AZIM.	LSE RANGE	EAU AZIM.	EAU RANGE	IDCU1 LSE	IDCU1 EAU	IDCU1 LAT.	GPS LAT	LSE ERROR	EAU ERROR

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

VDF Formal Operational Test and Evaluation Scenario #2 Results (EAU and LSE)

		LONG					AZIM.	AZIM.	LONG.	LONG		
	(NMB)	(DMIN)	(DEGRS)	(NM)	(DEGRS)	(NM)	(DEGRS)	(DEGRS)	(DMS)	(DEGRS)	(DEGRS)	(DEGRS)
8	151150	4421.55								44.35917		
		9126.75	342.1	33.8	178.6	30.6				91.44583		
10	151715	4436.76								44.61267		
		9129.78	345.2	49.0	183.3	15.3		179		91.49633		-4
13	154415	4453.47								44.89117		
		9114	358.9	64.1	84.2	10.9		80		91.23333		-4

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay 5 NM Radius Orbit Using 1 Second Transmissions

TIME (HMS)	IDCU1 GRB LAT. LONG. (DMS)	GPS LAT. LONG. (DMIN)	IDCU1 GRB AZIM. (DEGRS)	IDCU1 GRB LAT. LONG. (DEGRS)	GPS LAT. LONG. (DEGRS)	GRB ERROR (DEGRS)	GRB AZIM. (DEGRS)	GRB RANGE (NM)
213901		4423.83	196		44.3972	12	184.0	5.8
		8808.05			88.1342			
214001	441838	4424.24	170		44.4040	2	167.9	5.5
	880355	8805.86			88.0977			
214101	442550	4424.86	150		44.4143	-1	151.4	5.3
	880355	8803.87			88.0645			
214201	441336	4425.85	140	44.2267	44.4308	5	135.3	5.2
	874705	8802.33		87.7847	88.0388			
214301		4427.11	114		44.4518	-5	119.1	4.9
		8801.37			88.0228			
214401		4428.44	103		44.4740	1	102.4	4.8
		8800.75			88.0125			
214501		4429.86			44.4977		85.1	4.5
		8800.91			88.0152			
214601		4431.29	71		44.5215	5	66.4	4.5
		8801.34			88.0223			
214701		4432.50	49		44.5417	3	45.7	4.3
		8802.82			88.0470			
214802		4433.61	27		44.5602	4	22.9	4.4
		8804.66			88.0777			
214901		4434.18	359		44.5697	1	358.5	4.6
		8807.20			88.1200			
215001		4433.78	338		44.5630	5	332.9	4.6
		8809.99			88.1665			
215101		4432.72	310		44.5453	3	307.4	4.9
		8812.58			88.2097			
215201		4430.84	284		44.5140	2	281.9	5.2
		8814.28			88.2380			
215301		4428.52	261		44.4753	4	257.0	5.6
		8814.95			88.2492			
215401	435956	4426.31	240		44.4385	5	234.6	6.0
	891226	8814.20			88.2367			
215501		4424.96	220		44.4160	5	215.5	5.9
		8812.19			88.2032			
215601		4424.18	200		44.4030	4	196.4	5.7
		8809.73			88.1622			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point Data Collected During Green Bay 5 NM Radius Orbit Using 1 Second Transmissions

TIME (HMS)	IDCU1 GRB LAT. LONG. (DMS)	GPS LAT. LONG. (DMIN)	IDCU1 STE AZIM. (DEGRS)	GPS LAT. LONG. (DEGRS)	STE ERROR (DEGRS)	STE AZIM. (DEGRS)	STE RANGE (NM)
214001		4424.24	101	44.4040	6	95.3	62.1
		8805.96		88.0977			
214101		4424.86	95	44.4143	0	94.6	63.4
		8803.87		88.0645			
214201		4425.85	103	44.4308	9	93.6	64.4
		8802.33		88.0388			
214301		4427.11	79	44.4518	-13	92.4	64.9
		8801.37		88.0228			
214802		4433.61	295	44.5602	208	86.6	62.3
		8804.66		88.0777			
214901		4434.18	300	44.5697	214	86.1	60.5
		8807.20		88.1200			
215301		4428.52	267	44.4753	175	91.8	55.1
		8814.95		88.2492			
215401	435956	4426.31	156	44.4385	62	94.1	55.9
	891226	8814.20		88.2367			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay 5 NM Radius Orbit Using 5 Second Transmissions

TIME	IDCU1 GRB LAT. LONG.	GPS LAT. LONG.	IDCU1 GRB AZIM.	IDCU1 GRB LAT. LONG.	GPS LAT. LONG.	GRB ERROR	GRB AZIM.	GRB RANGE
(HMS)	(DMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
211805	442215	4424.80		44.3708	44.4133		220.1	6.5
	880904	8813.28		88.1511	88.2213			
211905		4423.68	204		44.3947	6	197.7	6.3
		8810.17			88.1695			
212005	442607	4424.15	185	44.4353	44.4025	4	181.2	5.5
	880731	8807.64		88.1253	88.1273			
212105		4424.45			44.4075		162.1	5.4
		8805.15			88.0858			
212205	442647	4425.29	153	44.4131	44.4215	7	145.9	5.1
	880330	8803.40		88.0583	88.0567			
212705		4432.11	57		44.5352	4	53.1	4.3
		8802.25			88.0375			
212805		4433.17	36		44.5528	3	32.7	4.3
		8803.80			88.0633			
212905		4433.92	15		44.5653	5	10.1	4.4
		8805.96			88.0993			
213105		4434.30	351		44.5717	3	348.4	4.8
		8808.37			88.1395			
213105		4433.40	326		44.5567	3	322.5	4.7
		8811.05			88.1842			
213205		4432.22	301		44.5370	3	297.8	5.3
		8813.67			88.2278			
213305		4430.06	275		44.5010	2	273.0	5.3
		8814.67			88.2445			
213405	442742	4427.77	254	44.4617	44.4628	5	249.5	5.8
	881539	8814.85		88.2608	88.2475			
213505	442713	4425.82	234	44.4536	44.4303	6	227.7	5.8
	881133	8813.45		88.1925	88.2242			
213605	442211	4424.38	210	44.3697	44.4063	1	209.2	6.1
	881254	8811.63		88.2150	88.1938			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point Data Collected During Green Bay 5 NM Radius Orbit Using 5 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 STE AZIM.	GPS LAT. LONG.	STE ERROR	STE AZIM.	STE RANGE
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
212005	4424.15	95	44.4025	-1	95.6	60.8
	8807.64		88.1273			
212105	4424.45	96	44.4075	1	95.1	62.5
	8805.15		88.0858			
212205	4425.29	96	44.4215	2	94.2	63.7
	8803.40		88.0567			
212905	4433.92	159	44.5653	73	86.3	61.4
	8805.96		88.0993			
213305	4430.06	109	44.5010	19	90.2	55.2
	8814.67		88.2445			
213405	4427.77	94	44.4628	1	92.6	55.3
	8814.85		88.2475			
213505	4425.82	94	44.4303	0	94.5	56.5
	8813.45		88.2242			
213605	4424.38	99	44.4063	3	95.7	58.0
	8811.63		88.1938			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay 10 NM Radius Orbit Using 5 Second Transmissions

TIME (HMS)	IDCU1 GRB LAT. LONG. (DMS)	GPS LAT. LONG. (DMIN)	IDCU1 GRB AZIM. (DEGRS)	IDCU1 GRB LAT. LONG. (DEGRS)	GPS LAT. LONG. (DEGRS)	GRB ERROR (DEGRS)	GRB AZIM. (DEGRS)	GRB RANGE (NM)
164705	442128	4421.75	228	44.3578	44.3625	6	221.6	10.8
	881909	8817.64		88.3192	88.2940			
164805		4420.59	216		44.3432	7	209.5	10.6
		8814.90			88.2483			
164905		4419.49	200		44.3248	4	196.4	10.7
		8811.89			88.1982			
165005		4418.77	186		44.3128	1	184.6	10.9
		8808.92			88.1487			
165105		4419.35	178		44.3225	5	173.5	10.3
		8806.05			88.1008			
165205		4419.57	167		44.3262	5	162.4	10.5
		8803.26			88.0543			
165305	442526	4420.44	158		44.3407	6	151.9	10.2
	880441	8800.90			88.0150			
165405		4421.54	143		44.3590	2	141.1	10.1
		8758.70			87.9783			
165505		4422.78	132		44.3797	2	130.2	10.2
		8756.64			87.9440			
165605		4424.43	126		44.4072	6	119.6	9.9
		8755.37			87.9228			
165705		4426.09	115		44.4348	6	109.2	9.8
		8754.44			87.9073			
165805		4427.84	104		44.4640	5	98.6	9.8
		8753.71			87.8952			
165905		4429.59	94		44.4932	6	88.3	9.5
		8753.94			87.8990			
170005		4431.33	82		44.5222	4	77.5	9.3
		8754.38			87.9063			
170105		4432.97	65		44.5495	-2	67.0	9.3
		8755.09			87.9182			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point Data Collected During Green Bay 10 NM Radius Orbit Using 5 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 STE AZIM.	GPS LAT. LONG.	STE ERROR	STE AZIM.	STE RANGE
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
164705	4421.75	101	44.3625	2	99.2	54.2
	8817.64		88.2940			
165105	4419.35	82	44.3225	-18	99.8	62.8
	8806.05		88.1008			
165305	4420.44	95	44.3407	-3	98.1	66.2
	8800.90		88.0150			
165405	4421.54	79	44.3590	-18	97.0	67.5
	8758.70		87.9783			
165505	4422.78	75	44.3797	-21	95.7	68.8
	8756.64		87.9440			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay 10 NM Radius Orbit Using 10 Second Transmissions

TIME (HMS)	IDCU1 GRB LAT. LONG. (DMS)	GPS LAT. LONG. (DMIN)	IDCU1 GRB AZIM. (DEGRS)	IDCU1 GRB LAT. LONG. (DEGRS)	GPS LAT. LONG. (DEGRS)	GRB ERROR (DEGRS)	GRB AZIM. (DEGRS)	GRB RANGE (NM)
170406		4437.35	36		44.6225	0	35.8	9.8
		8758.86			87.9810			
170506		4437.88	28		44.6313	3	25.0	9.3
		8801.36			88.0227			
170606		4438.53	19		44.6422	6	12.5	9.2
		8804.03			88.0672			
170706		4439.10	8		44.6517	5	2.9	9.5
		8806.13			88.1022			
170806		4439.26	357		44.6543	5	352.1	9.7
		8808.67			88.1445			
170906		4439.08	349		44.6513	8	341.2	9.9
		8811.31			88.1885			
171006	445430	4438.11	336	44.9083	44.6352	6	329.7	9.7
	882352	8813.72		88.3978	88.2287			
171106	443521	4436.98	317	44.5892	44.6163	-1	317.7	9.7
	881507	8816.07		88.2519	88.2678			
171306		4434.57			44.5762		295.9	10.7
		8820.51			88.3418			
171406		4432.41	287		44.5402	3	284.1	10.3
		8821.09			88.3515			
171506		4430.17	276		44.5028	5	271.4	10.3
		8821.60			88.3600			
171606		4427.97	262		44.4662	3	259.2	10.5
		8821.72			88.3620			
171706	442519	4425.83	247	44.4219	44.4305	0	247.1	10.5
	882008	8820.91		88.3356	88.3485			
171806	442354	4423.74	237	44.3983	44.3957	2	234.6	10.6
	881841	8819.61		88.3114	88.3268			
171906	442052	4421.87	228	44.3478	44.3645	5	223.2	11.0
	881957	8818.04		88.3325	88.3007			
172006		4420.66			44.3443		212.5	10.9
		8815.78			88.2630			
172106		4419.83			44.3305		201.8	10.7
		8813.22			88.2203			
172206		4419.28			44.3213		191.0	10.6
		8810.52			88.1753			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point Data Collected During Green Bay 10 NM Radius Orbit Using 10 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 STE AZIM.	GPS LAT. LONG.	STE ERROR	STE AZIM.	STE RANGE
(HMS)	(DMMN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
170706	4439.10	64	44.6517	-17	81.5	61.6
	8806.13		88.1022			
170806	4439.26		44.6543		81.2	59.8
	8808.67		88.1445			
170906	4439.08	66	44.6513	-15	81.1	57.9
	8811.31		88.1885			
171006	4438.11	65	44.6352	-17	81.9	56.1
	8813.72		88.2287			
171106	4436.98	86	44.6163	3	83.0	54.3
	8816.07		88.2678			
171406	4432.41	100	44.5402	11	88.6	50.6
	8821.09		88.3515			
171506	4430.17	74	44.5028	-16	90.4	50.3
	8821.60		88.3600			
171606	4427.97	96	44.4662	3	92.9	50.4
	8821.72		88.3620			
171706	4425.83	97	44.4305	2	95.2	51.2
	8820.91		88.3485			
171806	4423.74	98	44.3957	1	97.4	52.4
	8819.61		88.3268			
171906	4421.87	102	44.3645	3	99.1	53.9
	8818.04		88.3007			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay 40 NM Radius Orbit Using 5 Second Transmissions

TIME (HMS)	IDCU1 GRB LAT. LONG. (DMS)	GPS LAT. LONG. (DMIN)	IDCU1 GRB AZIM. (DEGRS)	IDCU1 GRB LAT. LONG. (DEGRS)	GPS LAT. LONG. (DEGRS)	GRB ERROR (DEGRS)	GRB AZIM. (DEGRS)	GRB RANGE (NM)
161505	445314	4453.99	308	44.8872	44.8998	3	305.5	40.5
	885312	8852.69		88.8867	88.8782			
161605	445116	4452.40	306	44.8544	44.8733	3	302.8	40.5
	885139	8854.23		88.8608	88.9038			
161805	444840	4448.40	300	44.8111	44.8067	3	296.5	40.0
	885826	8856.78		88.9739	88.9463			
161905	444623	4446.32	297	44.7731	44.7720	4	293.3	39.9
	885846	8857.99		88.9794	88.9665			
162005	444354	4444.51	293	44.7317	44.7418	3	290.2	40.4
	890116	8859.84		89.0211	88.9973			
162105		4442.40	288		44.7067	1	287.0	40.3
		8900.83			89.0138			
162205	444017	4440.30	288	44.6714	44.6717	4	284.0	40.2
	890015	8901.55		89.0042	89.0258			
162305	443753	4438.15	284	44.6314	44.6358	3	280.9	40.0
	890346	8901.94		89.0628	89.0323			
162405		4436.17	282		44.6028	4	278.0	40.0
		8902.51			89.0418			
162505		4434.27	279		44.5712	4	275.2	40.0
		8902.84			89.0473			
162605		4432.19	277		44.5365	5	272.2	40.0
		8903.07			89.0512			
162705		4429.97	274		44.4995	5	269.0	40.0
		8903.25			89.0542			
162805		4427.69	270		44.4615	4	265.8	40.6
		8903.96			89.0660			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay 40 NM Radius Orbit Using 5 Second Transmissions

TIME (HMS)	IDCU1 GRB LAT. LONG. (DMS)	GPS LAT. LONG. (DMIN)	IDCU1 GRB AZIN. (DEGRS)	IDCU1 GRB LAT. LONG. (DEGRS)	GPS LAT. LONG. (DEGRS)	GRB ERROR (DEGRS)	GRB AZIM. (DEGRS)	GRB RANGE (NM)
162905	442554	4425.32	267	44.4317	44.4220	5	262.4	40.5
	890653	8903.54		89.1147	89.0590			
163005	442333	4423.04	264	44.3925	44.3840	5	259.2	40.4
	890645	8903.02		89.1125	89.0503			
163105	442003	4420.93	258	44.3342	44.3488	2	256.1	40.4
	890025	8902.33		89.0069	89.0388			
163205	441719	4418.81	254	44.2886	44.3135	1	253.0	40.6
	885906	8901.87		88.9850	89.0312			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point Data Collected During Green Bay 40 NM Radius Orbit Using 5 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 STE AZIM.	GPS LAT. LONG.	STE ERROR	STE AZIM.	STE RANGE
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
161505	4453.99	52	44.8998	2	50.3	35.3
	8852.69		88.8782			
161605	4452.40	54	44.8733	3	51.3	33.5
	8854.23		88.9038			
161805	4448.40	57	44.8067	2	55.4	29.7
	8856.78		88.9463			
161905	4446.32	60	44.7720	2	58.1	27.9
	8857.99		88.9665			
162005	4444.51	62	44.7418	2	60.2	25.9
	8859.84		88.9973			
162105	4442.40	65	44.7067	1	63.8	24.3
	8900.83		89.0138			
162205	4440.30	70	44.6717	2	68.1	23.0
	8901.55		89.0258			
162305	4438.15	74	44.6358	1	73.1	22.1
	8901.94		89.0323			
162405	4436.17	79	44.6028	1	78.0	21.3
	8902.51		89.0418			
162505	4434.27	84	44.5712	1	83.0	20.8
	8902.84		89.0473			
162605	4432.19	89	44.5365	0	88.8	20.6
	8903.07		89.0512			
162705	4429.97	96	44.4995	1	95.0	20.6
	8903.25		89.0542			
162805	4427.69	104	44.4615	3	101.5	20.5
	8903.96		89.0660			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point Data Collected During Green Bay 40 NM Radius Orbit Using 5 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 STE AZIM.	GPS LAT. LONG.	STE ERROR	STE AZIM.	STE RANGE
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
162905	4425.32 8903.54	110	44.4220 89.0590	3	107.4	21.5
163005	4423.04 8903.02	116	44.3840 89.0503	3	112.6	22.7
163105	4420.93 8902.33	118	44.3488 89.0388	1	116.6	24.1
163205	4418.81 8901.87	122	44.3135 89.0312	2	120.5	25.5

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Marquette 10 NM Radius Orbit Using 5 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 MOT AZIM.	IDCU2 MOT AZIM.	GPS LAT. LONG.	IDCU1 MOT ERROR	IDCU2 MOT ERROR	MOT AZIM.	MOT RANGE
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
194405	4621.98	169	169	46.3663	4	4	165.2	10.1
	8730.15			87.5025				
194500	4623.17	154	154	46.3862	3	3	151.2	9.7
	8727.06			87.4510				
194600	4624.48	142	142	46.4080	6	6	136.4	9.8
	8723.97			87.3995				
194700	4626.38	126	126	46.4397	5	5	121.5	9.9
	8721.50			87.3583				
194800	4628.61	112	112	46.4768	5	5	106.7	10.0
	8719.72			87.3287				
194900	4631.06	96	96	46.5177	4	4	92.3	10.0
	8718.91			87.3152				
195000	4633.64	82	82	46.5607	5	5	77.5	10.1
	8719.04			87.3173				
195100	4636.15	68	68	46.6025	5	5	62.7	10.2
	8720.00			87.3333				
195200	4638.47	52	52	46.6412	4	4	47.8	10.3
	8721.90			87.3650				
195300	4639.99	38	38	46.6665	5	5	33.3	10.0
	8724.95			87.4158				
195400	4641.47	22	22	46.6912	4	4	18.3	10.3
	8728.18			87.4697				
195500	4642.19	9	9	46.7032	5	5	3.8	10.4
	8731.87			87.5312				
195600	4641.91	353	353	46.6985	4	4	348.8	10.2
	8735.78			87.5963				
195700	4641.38	341	341	46.6897	7	7	333.7	10.5
	8739.69			87.6615				

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Marquette 10 NM Radius Orbit Using 5 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 MQT AZIM.	IDCU2 MQT AZIM.	GPS LAT. LONG.	IDCU1 MQT ERROR	IDCU2 MQT ERROR	MQT AZIM.	MQT RANGE
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
195800	4639.78	321	321	46.6630	2	2	318.9	10.3
	8742.83			87.7138				
195900	4637.93	305	305	46.6322	1	1	303.9	10.5
	8745.71			87.7618				
200000	4635.48	296	296	46.5913	7	7	289.2	10.2
	8747.18			87.7863				
200100	4632.92	279	279	46.5487	5	5	274.2	10.4
	8748.39			87.8065				
200200	4630.24	265	265	46.5040	6	6	259.2	10.2
	8747.97			87.7995				
200300	4627.66	248	248	46.4610	5	5	243.5	10.0
	8746.60			87.7767				
200400	4625.43	233	233	46.4238	4	4	228.6	10.1
	8744.65			87.7442				
200600	4622.60	203	203	46.3767	5	5	198.3	9.8
	8738.34			87.6390				
200700	4621.99	186	186	46.3665	3	3	182.6	9.9
	8734.55			87.5758				
200800	4622.21	173	173	46.3702	5	5	168.4	9.8
	8731.04			87.5173				
200900	4623.07	156	156	46.3845	3	3	153.0	9.7
	8727.49			87.4582				

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Rhinelander 10 NM Radius Orbit Using 5 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 RNI AZIM.	IDCU2 RNI AZIM.	GPS LAT. LONG.	RNI IDCU1 ERROR	RNI IDCU2 ERROR	RNI AZIM. GPS	RNI RANGE GPS
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
204502	4546.55	30	30	45.7758	-2	-2	32.3	9.7
	8920.68			89.3447				
204600	4547.58	17	15	45.7930	1	-1	16.4	9.7
	8924.25			89.4042				
204700	4547.86	1	0	45.7977	0	-1	0.6	9.7
	8928.05			89.4675				
204800	4547.49	349	349	45.7915	4	4	345.1	9.7
	8931.76			89.5293				
204900	4546.49	332	332	45.7748	3	3	329.4	9.9
	8935.32			89.5887				
205000	4544.8	314	314	45.7467	0	0	314.2	9.9
	8938.17			89.6362				
205100	4542.83	301	301	45.7138	1	1	299.8	10.0
	8940.38			89.6730				
205200	4540.41	285	286	45.6735	0	1	284.9	10.1
	8941.71			89.6952				
205300	4537.9	271	271	45.6317	1	1	270.5	10.0
	8942.04			89.7007				
205400	4535.38	256	256	45.5897	0	0	256.0	10.1
	8941.6			89.6933				
205500	4532.92	242	241	45.5487	1	0	241.3	10.3
	8940.32			89.6720				
205600	4531.05	226	226	45.5175	-1	-1	227.5	10.2
	8938.04			89.6340				
205700	4529.42	213	213	45.4903	0	0	213.4	10.3
	8935.34			89.5890				
205800	4528.18	198	198	45.4697	-1	-1	199.2	10.5
	8932.11			89.5352				
205900	4527.92	182	182	45.4653	-4	-4	185.5	10.3
	8928.6			89.4767				

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS HOURS MINUTES SECONDS NM - NAUTICAL MILES

Rhinelander 20 NM Radius Orbit Using 5 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 RNI AZIM.	IDCU2 RNI AZIM.	GPS LAT. LONG.	IDCU1 RNI ERROR	RNI IDCU1 ERROR	RNI AZIM. GPS	RNI RANGE GPS
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
210600	4521.43	147	147	45.3572	-2	-2	148.8	20.0
	8912.12			89.2020				
210700	4523.09	139	139	45.3848	-2	-2	141.4	19.9
	8909.29			89.1548				
210800	4524.81	133	133	45.4135	-1	-1	133.6	20.1
	8906.27			89.1045				
210900	4526.88	124	124	45.4480	-2	-2	126.1	20.1
	8903.99			89.0665				
211000	4529.26	116	116	45.4877	-3	-3	118.6	19.9
	8902.42			89.0403				
211100	4531.78	109	109	45.5297	-2	-2	110.9	19.7
	8901.15			89.0192				
211200	4534.31	100	100	45.5718	-3	-3	103.1	19.9
	8859.91			88.9985				
211300	4536.99	93	93	45.6165	-2	-2	95.3	19.7
	8859.59			88.9932				
211400	4539.62	86	86	45.6603	-2	-2	87.6	19.7
	8859.65			88.9942				
211500	4542.31	77	77	45.7052	-3	-3	79.7	19.7
	8900.22			89.0037				
211700	4547.3	62	62	45.7883	-2	-2	64.1	19.6
	8902.86			89.0477				
211800	4549.58	53	49	45.8263	-3	-7	56.1	19.5
	8905.04			89.0840				

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point 5 NM Radius Orbit Using 1 Second Transmissions

TIME (HMS)	GPS LAT. LONG. (DMIN)	IDCU1 STE LAT. LONG. (DMS)	IDCU1 STE AZIN. (DEGRS)	IDCU1 STE LAT. LONG. (DEGRS)	GPS LAT. LONG. (DEGRS)	STE IDCU1 ERROR (DEGRS)	STE AZIN. GPS (DEGRS)	STE RANGE GPS (NM)
203601	4433.13		81		44.5522	-1	82.4	4.8
	8925.22				89.4203			
203701	4434.35	443250	67	44.5472	44.5725	0	66.9	4.8
	8925.80	893034		89.5094	89.4300			
203801	4435.67	443321	51	44.5558	44.5945	0	50.9	5.1
	8926.45	893018		89.5050	89.4408			
203901	4436.81	443539	33	44.5942	44.6135	2	31.5	5.1
	8928.24	892854		89.4817	89.4707			
204201	4436.41	443301	324	44.5503	44.6068	1	323.4	5.0
	8936.13	893229		89.5414	89.6022			
204401	4432.60		273		44.5433	1	272.2	5.1
	8939.01				89.6502			
204501	4430.53	443222	246	44.5394	44.5088	-2	248.3	5.1
	8938.50	893210		89.5361	89.6417			
204601	4428.81	443041	219	44.5114	44.4802	-6	225.4	5.1
	8937.00	893357		89.5658	89.6167			
204701	4427.72	442711	203	44.4531	44.4620	-1	204.1	5.2
	8934.81	893507		89.5853	89.5802			
204801	4427.37	442711	182	44.4531	44.4562	-2	184.1	5.1
	8932.37	893214		89.5372	89.5395			
204901	4427.67	442633	163	44.4425	44.4612	-1	164.1	5.0
	8929.94	892928		89.4911	89.4990			
205001	4428.32	442648	143	44.4467	44.4720	-1	143.5	5.2
	8927.56	892604		89.4344	89.4593			
205101	4429.50	442736	126	44.4600	44.4917	1	124.9	5.2
	8925.88	892244		89.3789	89.4313			
205201	4431.13				44.5188		106.3	4.8
	8925.40				89.4233			
205300	4432.75		87		44.5458	0	87.1	5.1
	8926.80				89.4133			
205400	4434.24	443117	71	44.5214	44.5707	0	70.7	5.3
	8924.94	892824		89.4733	89.4157			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay Data Collected During Stevens Point 5 NM Radius Orbit Using 1 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 GRB AZIM.	GPS LAT. LONG.	GRB IDCU1 ERROR	GRB AZIM. GPS	GRB RANGE GPS
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
203601	4433.13	276	44.5522	1	274.6	55.8
	8925.22		89.4203			
203701	4434.35	275	44.5725	-1	275.8	56.3
	8925.80		89.4300			
203801	4435.67	276	44.5945	-1	277.1	56.9
	8926.45		89.4408			
203901	4436.81	278	44.6135	0	278.1	58.3
	8928.24		89.4707			
204201	4436.41	276	44.6068	-1	277.1	63.8
	8936.13		89.6022			
204401	4432.60	275	44.5433	1	273.6	65.6
	8939.01		89.6502			
204501	4430.53	275	44.5088	3	271.8	65.2
	8938.50		89.6417			
204601	4428.21	273	44.4802	3	270.3	64.2
	8937.00		89.6167			
204701	4427.72	270	44.4620	1	269.3	62.6
	8934.81		89.5802			
204801	4427.37	270	44.4562	1	268.9	60.9
	8932.37		89.5395			
204901	4427.67	269	44.4612	0	269.1	59.1
	8929.94		89.4990			
205001	4428.32	269	44.4720	-1	269.7	57.4
	8927.56		89.4593			
205101	4429.50	270	44.4917	0	270.2	56.2
	8925.88		89.4313			
205300	4432.75	273	44.5458	-1	274.2	55.5
	8924.80		89.4133			
205400	4434.24	276	44.5707	0	275.7	55.7
	8924.94		89.4157			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point 5 NM Radius Orbit Using 2 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 STE LAT. LONG.	IDCU1 STE AZIM.	IDCU1 STE LAT. LONG.	GPS LAT. LONG.	IDCU1 STE ERROR	STE AZIM. GPS	STE RANGE GPS
(HMS)	(DMIN)	(DMS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
201402	4437.09	443449	27	44.5803	44.6182	3	23.6	5.1
	8929.14	893012		89.5033	89.4857			
201502	4437.41	443446	6	44.5794	44.6235	3	2.6	5.0
	8931.66	893131		89.5253	89.5277			
201600	4436.74	444349	340	44.7303	44.6123	1	338.8	4.6
	8934.32	894535		89.7597	89.5720			
201700	4435.51		312		44.5918	0	312.0	4.6
	8936.78				89.6130			
201802	4433.89		288		44.5648	2	286.4	5.3
	8939.03				89.6505			
201902	4431.70		262		44.5283	0	262.2	5.2
	8939.07				89.6512			
202002	4429.72	442959	238	44.4997	44.4953	1	237.3	5.0
	8937.75	893732		89.6256	89.6292			
202102	4428.22	443001	211	44.5003	44.4703	-2	213.2	5.0
	8935.72	893357		89.5658	89.5953			
202202	4427.66	442650	191	44.4472	44.4510	-1	191.8	4.9
	8933.26	893330		89.5583	89.5543			
202302	4427.60	442741	170	44.4614	44.4600	0	169.6	4.9
	8930.61	893048		89.5133	89.5102			
202402	4428.04	442854	150	44.4817	44.4673	0	150.1	5.1
	8928.29	892909		89.4858	89.4715			
202502	4429.06	442926	133	44.4906	44.4843	1	132.2	5.1
	8926.58	892729		89.4581	89.4430			
202602	4430.45	443028	115	44.5078	44.5075	1	114.0	5.0
	8925.48	892606		89.4350	89.4247			
202702	4432.10		95		44.5350	0	94.7	4.7
	8925.31				89.4218			
202802	4433.74		74		44.5623	0	74.0	4.6
	8925.80				89.4300			
202902	4435.34	443519	55	44.5886	44.5890	1	54.3	4.9
	8926.36	892607		89.4353	89.4393			
203002	4436.73	443521	37	44.5892	44.6122	1	35.9	5.3
	8927.65	892846		89.4794	89.4608			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay Data Collected During Stevens Point 5 NM Radius Orbit Using 2 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 GRB AZIM.	GPS LAT. LONG.	GRB IDCU1 ERROR	GRB AZIM. GPS	GRB RANGE GPS
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
201402	4437.09	277	44.6182	-1	278.3	58.9
	8929.14		89.4857			
201502	4437.41	277	44.6235	-1	278.4	60.8
	8931.66		89.5277			
201600	4436.74	277	44.6123	-1	277.6	62.6
	8934.32		89.5720			
201700	4435.51	276	44.5918	0	276.3	64.2
	8936.78		89.6130			
201802	4433.89	276	44.5648	1	274.8	65.7
	8939.03		89.6505			
201902	4431.70	273	44.5283	0	272.9	65.6
	8939.07		89.6512			
202002	4429.72	273	44.4953	2	271.1	64.7
	8937.75		89.6292			
202102	4428.22	273	44.4703	3	269.8	63.3
	8935.72		89.5953			
202202	4427.66	270	44.4610	1	269.2	61.5
	8933.26		89.5543			
202302	4427.60	270	44.4600	1	269.0	59.6
	8930.61		89.5102			
202402	4428.04	272	44.4673	3	269.4	58.0
	8928.29		89.4715			
202502	4429.06	272	44.4843	2	270.4	56.7
	8926.58		89.4430			
202602	4430.45	273	44.5075	1	271.8	55.9
	8925.48		89.4247			
202702	4432.10	274	44.5350	0	273.5	55.8
	8925.31		89.4218			
202802	4433.74	277	44.5623	2	275.2	56.3
	8925.80		89.4300			
202902	4435.34	278	44.5890	1	276.8	56.8
	8926.36		89.4393			
203002	4436.73	278	44.6122	0	278.0	57.8
	8927.65		89.4608			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point 5 NM Radius Orbit Using 10 Second Transmissions

TIME (HMS)	GPS LAT. LONG. (DMIN)	IDCU1 STE LAT. LONG. (DMS)	IDCU1 STE AZIM. (DEGRS)	IDCU1 STE LAT. LONG. (DEGRS)	GPS LAT. LONG. (DEGRS)	STE IDCU1 ERROR (DEGRS)	STE AZIM. GPS (DEGRS)	STE RANGE GPS (NM)
194406	4437.26	443427	9	44.5742	44.6210	2	7.0	4.8
	8931.15	893127		89.5242	89.5192			
194505	4434.91				44.6152		336.8	4.9
	8934.67				89.5778			
194606	4435.57	443326	313	44.5572	44.5928	1	312.0	4.7
	8936.88	893323		89.5564	89.6147			
194705	4433.27	443326	283	44.5572	44.5545	2	281.1	4.5
	8938.07	893323		89.5564	89.6345			
194805	4430.84	443143	251	44.5286	44.5140	0	250.6	4.7
	8938.14	893454		89.5817	89.6357			
194905	4428.73	443011	224	44.5031	44.4788	0	223.9	5.1
	8936.84	893501		89.5836	89.6140			
195005	4427.60	442737	201	44.4603	44.4600	1	199.8	5.1
	8934.29	893432		89.5756	89.5715			
195105	4427.52	442738	177	44.4606	44.4587	1	176.5	5.0
	8931.43	893138		89.5272	89.5238			
195205	4428.21	442815	155	44.4708	44.4702	0	155.0	4.7
	8929.08	892916		89.4878	89.4847			
195305	4429.18	442853	134	44.4814	44.4863	1	133.1	4.8
	8926.94	892813		89.4703	89.4490			
195405	4430.58	442956	114	44.4989	44.5097	2	112.4	5.0
	8925.39	892402		89.4006	89.4232			
195506	4432.24		93		44.5373	0	92.8	5.2
	8924.60				89.4100			
195605	4433.98	443346	73	44.5628	44.5663	1	71.7	4.8
	8925.58	892545		89.4292	89.4263			
195705	4435.64	443333	50	44.5592	44.5940	0	49.7	4.9
	8926.72	893000		89.5000	89.4453			
195806	4437.05	443519	30	44.5886	44.6175	3	27.3	5.2
	8928.65	892934		89.4928	89.4775			
195906	4437.70	443601	8		44.6283	2	6.0	5.3
	8931.21	893112			89.5202			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point 5 NM Radius Orbit Using 10 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 STE LAT. LONG.	IDCU1 STE AZIM.	IDCU1 STE LAT. LONG.	GPS LAT. LONG.	STE IDCU1 ERROR	STE AZIM. GPS	STE RANGE GPS
(HMS)	(DMIN)	(DMS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
200005	4436.85	443343	341		44.6142	1	339.7	4.7
	8934.27	893231			89.5712			
200105	4435.67	443852			44.5945		311.9	4.9
	8937.04	895031			89.6173			
200205	4433.74		287		44.5623	2	285.3	5.1
	8938.81				89.6468			
200305	4431.26		257		44.5210	0	256.5	4.9
	8938.60				89.6433			
200405	4429.09		229		44.4848	1	228.0	5.0
	8937.05				89.6175			
200505	4428.02	442802	203	44.4672	44.4670	1	202.4	4.8
	8934.41	893436		89.5767	89.5735			
200605	4427.87	442847	179	44.4797	44.4645	1	178.1	4.6
	8931.65	893152		89.5311	89.5275			
200705	4428.05	442826	156	44.4739	44.4675	0	155.6	4.9
	8929.05	892924		89.4900	89.4842			
200805	4428.57	442855	137	44.4819	44.4762	-1	137.6	5.3
	8926.87	892727		89.4575	89.4478			
200905	4430.04	442944	121	44.4956	44.5007	2	119.1	5.0
	8925.73	892539		89.4275	89.4288			
201005	4431.71		100		44.5285	1	99.4	4.8
	8925.32				89.4220			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay Data Collected During Stevens Point 5 NM Radius Orbit Using 10 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 GRB AZIM.	GPS LAT. LONG.	GRB IDCU1 ERROR	GRB AZIM. GPS	GRB RANGE GPS
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
194406	4437.26	277	44.6210	-1	278.3	60.4
	8931.15		89.5192			
194505	4436.91		44.6152		277.7	62.8
	8934.67		89.5778			
194606	4435.57	276	44.5928	0	276.3	64.3
	8936.88		89.6147			
194705	4433.27	275	44.5545	1	274.3	65.0
	8938.07		89.6345			
194805	4430.84	274	44.5140	2	272.1	65.0
	8938.14		89.6357			
194905	4428.73	273	44.4788	3	270.2	64.0
	8936.84		89.6140			
195005	4427.60	270	44.4600	1	269.1	62.3
	8934.29		89.5715			
195105	4427.52	270	44.4587	1	269.0	60.2
	8931.43		89.5238			
195205	4428.21	271	44.4702	1	269.6	58.5
	8929.08		89.4847			
195305	4429.18	273	44.4863	3	270.5	57.0
	8926.94		89.4490			
195405	4430.58	273	44.5097	1	271.9	55.9
	8925.39		89.4232			
195506	4432.24	273	44.5373	-1	273.7	55.3
	8924.60		89.4100			
195605	4433.98	277	44.5663	2	275.4	56.1
	8925.58		89.4263			
195705	4435.64	276	44.5940	-1	277.0	57.1
	8926.72		89.4453			
195806	4437.05	278	44.6175	0	278.3	58.6
	8928.65		89.4775			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay Data Collected During Stevens Point 5 NM Radius Orbit Using 10 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 GRB AZIM.	GPS LAT. LONG.	GRB IDCU1 ERROR	GRB AZIM. GPS	GRB RANGE GPS
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
195906	4437.70	278	44.6283	-1	278.7	60.5
	8931.21		89.5202			
200005	4436.85	276	44.6142	-2	277.7	62.6
	8934.27		89.5712			
200105	4435.67		44.5945		276.4	64.4
	8937.04		89.6173			
200205	4433.74	275	44.5623	0	274.6	65.5
	8938.81		89.6468			
200305	4431.26	275	44.5210	3	272.5	65.3
	8938.60		89.6433			
200405	4429.09	272	44.4848	2	270.4	64.2
	8937.05		89.6175			
200505	4428.02	271	44.4670	1	269.5	62.3
	8934.41		89.5735			
200605	4427.87	272	44.4645	3	269.3	60.4
	8931.65		89.5275			
200705	4428.05	271	44.4675	2	269.4	58.5
	8929.05		89.4842			
200805	4428.57	272	44.4762	2	269.9	56.9
	8926.87		89.4478			
200905	4430.04	272	44.5007	1	271.4	56.1
	8925.73		89.4288			
201005	4431.71	273	44.5285	0	273.1	55.8
	8925.32		89.4220			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point 10 NM Radius Orbit Using 10 Second Transmissions

TIME (HMS)	GPS LAT. LONG. (DMIN)	IDCU1 STE LAT. LONG. (DMS)	IDCU1 STE AZIM. (DEGRS)	IDCU1 STE LAT. LONG. (DEGRS)	GPS LAT. LONG. (DEGRS)	IDCU1 STE ERROR (DEGRS)	STE AZIM. GPS (DEGRS)	STE RANGE GPS (NM)
191010	4436.99	443609	60	44.6025	44.6165	-1	60.7	9.2
	8920.74	892239		89.3775	89.3457			
191410	4441.77	444053	13	44.6814	44.6962	1	12.0	9.5
	8929.24	892904		89.4844	89.4873			
191610	4442.04		346		44.7007	0	345.5	9.9
	8935.52				89.5920			
191811	4439.56	443920	317	44.6556	44.6593	1	316.3	9.9
	8941.65	894340		89.7278	89.6942			
192010	4435.76				44.5960		290.2	9.9
	8944.93				89.7488			
192210	4430.86		261		44.5143	0	261.3	9.9
	8945.56				89.7593			
192410	4426.44	442807	234	44.4686	44.4407	0	233.7	10.0
	8943.16	894020		89.6722	89.7193			
192610	4423.57	442421	207	44.4058	44.3928	-1	207.7	10.0
	8938.29	893752		89.6311	89.6382			
192810	4422.48	442337	183	44.3936	44.3747	-1	183.8	10.0
	8932.72	893240		89.5444	89.5453			
193010	4422.96	442324	162	44.3900	44.3827	0	161.8	10.0
	8927.41	892748		89.4633	89.4568			
193210	4424.84	442510	142	44.4194	44.4140	2	140.5	9.9
	8922.98	892358		89.3994	89.3830			
193410	4427.61				44.4602		120.0	9.8
	8919.95				89.3325			
193611	4431.24		100		44.5207	3	97.3	10.1
	8917.87				89.2978			
193810	4434.51		79		44.5752	0	78.6	10.1
	8918.12				89.3020			
194000	4438.06	443617	57	44.6047	44.6343	0	56.8	10.2
	8920.07	892332		89.3922	89.3345			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay Data Collected During Stevens Point 10 NM Radius Orbit Using 10 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 GRB AZIM.	GPS LAT. LONG.	GRB IDCU1 ERROR	GR3 AZIM. GPS	GRB RANGE GPS
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
191010	4436.99	279	44.6165	0	278.9	53.0
	8920.74		89.3457			
191410	4441.77	283	44.6962	0	282.7	59.8
	8929.24		89.4873			
191610	4442.04	282	44.7007	0	282.2	64.2
	8935.52		89.5920			
191811	4439.56	279	44.6593	0	279.5	68.1
	8941.65		89.6942			
192010	4435.76		44.5960		276.1	70.0
	8944.93		89.7488			
192210	4430.86	275	44.5143	3	272.1	70.3
	8945.56		89.7593			
192410	4426.44	271	44.4407	3	268.4	68.7
	8943.16		89.7193			
192610	4423.57	268	44.3928	2	265.7	65.4
	8938.29		89.6382			
192810	4422.48	267	44.3747	3	264.3	61.6
	8932.72		89.5453			
193010	4422.96	266	44.3827	2	264.3	57.7
	8927.41		89.4568			
193210	4424.84	268	44.4140	2	265.9	54.4
	8922.98		89.3830			
193410	4427.61		44.4602		268.7	52.0
	8919.95		89.3325			
193611	4431.24	274	44.5207	1	272.8	50.5
	8917.87		89.2978			
193810	4434.51	277	44.5752	1	276.4	50.9
	8918.12		89.3020			
194000	4438.06	279	44.6343	-1	280.2	52.7
	8920.07		89.3345			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Stevens Point 40 NM Radius Orbit Using 5 Second Transmissions

TIME (HMS)	GPS LAT. LONG. (DMIN)	IDCU1 STE LAT. LONG. (DMS)	IDCU1 STE AZIM. (DEGRS)	IDCU1 STE LAT. LONG. (DEGRS)	GPS LAT. LONG. (DEGRS)	IDCU1 STE ERROR (DEGRS)	STE AZIM. GPS (DEGRS)	STE RANGE GPS (NM)
154205	4436.8	443622	83	44.6061	44.6133	-1	83.7	38.9
	8837.78	883822		88.6394	88.6297			
154305	4438.56	443858	79	44.6494	44.6427	-2	81.2	39.2
	8837.62	883852		88.6478	88.6270			
154405	4440.16	444014	77	44.6706	44.6693	-2	78.8	39.2
	8838.03	884118		88.6883	88.6338			
154505	4441.58	444158	74	44.6994	44.6930	-3	76.5	38.8
	8839.08	884133		88.6925	88.6513			
154605	4443.24	444250	74	44.7139	44.7207	0	74.0	38.9
	8839.54	883952		88.6644	88.6590			
154705	4444.98	444433	72	44.7425	44.7497	1	71.4	38.9
	8840.29	883810		88.6361	88.6715			
154805	4446.71	444706	67	44.7850	44.7785	-2	68.6	38.8
	8841.28	884117		88.6881	88.6880			
154905	4448.45	444802	64	44.8006	44.8075	-2	65.8	38.8
	8842.3	884504		88.7511	88.7050			
155005	4450.28	444955	61	44.8319	44.8380	-2	62.9	38.9
	8843.36	884541		88.7614	88.7227			
155105	4452.01	445119	60	44.8553	44.8668	0	60.1	39.0
	8844.54	884407		88.7353	88.7423			
155205	4453.57	445112	58	44.8533	44.8928	1	57.3	39.0
	8845.95	884848		88.8133	88.7658			
155305	4455.06	445403	54	44.9008	44.9177	-1	54.5	38.8
	8847.68	884852		88.8144	88.7947			
155405	4456.56	445522	52	44.9228	44.9427	0	51.9	38.9
	8849.08	884907		88.8186	88.8180			
155505	4457.98	445650	46	44.9472	44.9663	-3	49.1	38.9
	8850.76	885533		88.9258	88.8460			
155605	4459.28		46		44.9880	0	46.4	38.8
	8852.66				88.8777			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Green Bay Data Collected During Stevens Point 40 NM Radius Orbit Using 5 Second Transmissions

TIME	GPS LAT. LONG.	IDCU1 GRB AZIM.	GPS LAT. LONG.	GRB IDCU1 ERROR	GRB AZIM. GPS	GRB RANGE GPS
(HMS)	(DMIN)	(DEGRS)	(DEGRS)	(DEGRS)	(DEGRS)	(NM)
154205	4436.8	289	44.6133	0	288.9	23.0
	8837.78		88.6297			
154305	4438.56	295	44.6427	2	293.1	23.5
	8837.62		88.6270			
154405	4440.16	296	44.6693	0	296.4	24.4
	8838.03		88.6338			
154505	4441.58	299	44.6930	1	298.5	25.7
	8839.08		88.6513			
154605	4443.24	302	44.7207	1	301.3	26.8
	8839.54		88.6590			
154705	4444.98	306	44.7497	2	303.8	28.2
	8840.29		88.6715			
154805	4446.71	308	44.7785	2	305.9	29.7
	8841.28		88.6880			
154905	4448.45	306	44.8075	-2	307.8	31.3
	8842.3		88.7050			
155005	4450.28	309	44.8380	-1	309.5	33.0
	8843.36		88.7227			
155105	4452.01	312	44.8668	1	310.9	34.8
	8844.54		88.7423			
155205	4453.57	308	44.8928	-4	311.8	36.6
	8845.95		88.7658			
155305	4455.06	312	44.9177	0	312.2	38.5
	8847.68		88.7947			
155405	4456.56	313	44.9427	0	312.9	40.2
	8849.08		88.8180			
155505	4457.98	310	44.9663	-3	313.3	42.0
	8850.76		88.8460			
155605	4459.28	309	44.9880	-4	313.4	43.9
	8852.66		88.8777			

DMIN - DEGREES MINUTES DMS - DEGREES MINUTES SECONDS DEGRS - DEGREES HMS - HOURS MINUTES SECONDS NM - NAUTICAL MILES

Orbital data was collected during OT&E activities in order to address questions of total system consistency and accuracy. The method of data collection was to transmit a series of identical messages from the aircraft to the VDF system as the aircraft orbited each of four selected VDF sites. For 10 second transmissions the GPS position was frozen for later recording at five seconds into the transmission, for the 1 to 5 second transmissions the position was frozen at the end of the transmission. This GPS position was recorded as was the angular position as reported to each of the IDCU consoles. Time was synchronized at flight start and was used as a cross check during the match of aircraft and ground collected data.

The GPS position is presented as latitude (lat.) and longitude (long.) in whole number of degrees and minutes to two decimal places. The latitude and longitude of each DF site is known in degrees, minutes, and seconds. The angle from the DF site to the aircraft was derived using the Cosine-Haversine formulas for Site Reduction in Duttons's Navigation & Piloting, 13th edition[1] on pages 553 and 554. These formulas use a spherical Earth model which is sufficiently accurate given the short distances and the 45 degree latitude of the test. The formulas are:

angle of distance =
ARCSINE[SINE[site lat.] * SINE[aircraft lat.] +
COSINE[site lat.] * COSINE[aircraft lat.] *
COSINE[aircraft long. - site long.]

Azimuth = ARCSINE[COSINE[aircraft lat.] *
SINE[aircraft long. - site long.] / COSINE[angle of distance]

Distance = Earth Radius (3444 NM) * COSINE[angle of distance]

The azimuth is corrected for quadrant using an algorithm derived from the following picture, where the DF site is assumed to exist at the origin (center) and NORTH is up:

[1]Duttons's Navigation & Piloting, 13ed.
Elbert S. Maloney, Naval Institute Press,
Annapolis, Maryland 1978

Aircraft Lat. > Site Lat. Aircraft Long. > Site Long. (270 to 359 degrees)	Aircraft Lat. > Site Lat. Aircraft Long. < Site Long. (0 to 89 degrees)
Aircraft Lat. < Site Lat. Aircraft Long. > Site Long. (180 to 269 degrees)	Aircraft Lat. < Site Lat. Aircraft Long. < Site Long. (90 to 179 degrees)

It is assumed that the difference in longitude is less than 90 degrees, and the latitudes are of the same name (NORTH). It is also assumed that spherical translation offers acceptable accuracy, nearer the poles the use of a spheroidal model would be more appropriate to compensate for the flattening of the sphere that exists there.

The final modification to the azimuth is to add the magnetic correction as entered in the VHF DF system data base at the time of the OT&E test, and to insure that the result is in the range 0 to 359 degrees.

SECTION 6

COMMENTS ON TECHNICAL INSTRUCTION AND MAINTENANCE ISSUES

Revised versions of the technical instruction manuals (TI 6530.10 and TI 6530.11) were reviewed during the Formal OT&E test. During the informal review the documents' instructions were compared with the equipment at the OT&E site. The result is a set of comments which should be addressed before deployment.

TI 6530.10 Comments:

1. Figure 3-1 should have a label on the RS-232 jack describing it as an RS-232 jack.

2. Figures 6-5, 6-6, and pages 6-15 through 6-17 have handwritten corrections that may make the document less than camera ready.

3. In paragraph 3.3, the last sentence indicates that the IOT-3 is "in the rack", IOT-3s are not rack mountable. Also, "and removed" could be changed to "and the cable removed."

4. There is a sometimes used screen labeling code on the IOT-3 display and in the document, this is a potentially useful feature. It would be best if it appeared on all screens, which it currently does not.

5. No option for exiting the DF SITE CALIBRATION MENU is apparent in the instruction book or on the IOT-3 screen. A 'Q' will allow exit from the menu.

6. Photographs on pages 7-14 through 7-17 and 7-19 are nearly illegible.

7. On page 7-60 replace the phrase "The time base modules is provides" with "The time base module provides."

8. There are occurrences of a confusing notational technique: p.5 to mean plus or minus 5, suggest either spelling this out or use the conventional symbol.

TI 6530.10 Comments:

1. In section 2.2.1.3 automatic screen dimmers are described. No such screen dimmer function was ever evidenced in the actual equipment. And there seem to be less security levels described than there are (6).

Maintenance Problems

December 1992/January 1993

The FA-10121 systems at Eau Claire and Marquette were installed and checked out. This was done in preparation for OT&E testing.

January 1993 - Green Bay antenna site experiences a failure just before testing started. A depot level adjustment was made by the contractor. This fix would have required replacement with a spare in the current maintenance plan. FAA field technicians are not trained on how to make the adjustment nor do they have the computer equipment necessary to make the adjustment.

April 1993 - Before OT&E commenced HSTX sent an engineer to the Eau Claire antenna site to make adjustments. It is believed that the same adjustment made in January at Green Bay antenna site was made at Eau Claire. This adjustment is a depot level adjustment, field maintenance would have had to swap the unit for a spare.

April 1993 - Modem failure causes replacement with spare. During the course of the test this modem also appeared to fail, swapped back to original modem. This may have been caused by overheating which the site technicians solved by removing a metal panel at the top front of the RMMC rack.

June 1993 - Before OT&E began repeated failures of remote tests of Marquette forced HSTX to send an engineer to fix the site. No report of the fix needed was given to ACW-300. The Marquette site often fails during remote maintenance tests, retesting usually gives the conflicting answer that the site has passed. The site accuracy orbits appear more stable than Green Bay's, although there is less data for the Marquette site. This site had the same problem at the April test but no attempt was made to fix it.

June 1993 - During OT&E the Trackball at the Operations console failed and was switched with the one in the training room.

These repairs imply that between the preventive maintenance and the April OT&E test all three of the installed FA-10121 sites required some form of repair. In two cases the repair was depot level, in the third case no fix was attempted until June. The third fix when made did not correct the problem, nor did it isolate the cause of the intermittent failures. The allowed mean time to failure is 4200 hours or 175 days or 4.8 months. So within the 4200 hours all three FA-10121 sites had required some form of maintenance.

It should be noted that three sites do not comprise a statistical sample. The Marquette problem may well be a combination of site and software. However, the combination of these failures is not expected from the factory tests of reliability.

The trackball was redesigned for this OT&E, and so a new one failed within 7 months. Our experience with this design is limited. However, trackballs are mechanical and they will wear out. Just as with the antenna sites we recommend that a watch be kept on this part, if only to better predict replacement requirements.

The apparent modem failure occurred in a rack with all modem case temperatures high enough to be painful to touch. Ventilation of the rack is passive with no vents at the top of the case. Removing the top front plate resulted in modems only slightly warm to the touch. No modems failed after the panel was removed, the "failed" modem was back in the rack and working at this point. This failure does not appear to be a maintenance issue.

SECTION 7

ACRONYMS AND ABBREVIATIONS

ADF	Automatic Direction Finder
AF	Airway Facilities
AFSS	Automated Flight Service Station
APMT	Associate Program Manager for Test
AT	Air Traffic
CHI	Computer Human Interface
COTS	Commercial Off-the-Shelf
CPU	Central Processor Unit
DF	Direction Finder
DME	Distance Measuring Equipment
EAU	Eau Claire VDF Antenna Site
ELT	Emergency Locator Transmitter
FAA	Federal Aviation Administration
GPS	Global Positioning System
GRB	Green Bay VDF Antenna Site
IDCU	Information Display Control Unit
IFR	Instrument Flight Rules
IOT	Input/Output Terminal
LAT	Latitude
LONG	Longitude
LSE	Lacrosse VDF Antenna Site
MDT	Maintenance Data Terminal
MOA	Military Operations Area
MPS	Maintenance Processor Subsystem
MQT	Marquette VDF Antenna Site
MTBF	Mean Time Between Failures
MTP	Master Test Plan

MSD	Multiple Signal Detect
NAS	National Airspace System
NAVAID	Navigational Aid
NDB	Nondirectional Radio Beacon
nmi	nautical mile
OT&E	Operational Test and Evaluation
PD	Purchase Description
PM	Preventative Maintenance
RHI	Rhinelander VDF Antenna Site
RMM	Remote Maintenance Monitoring
RMMC	Remote Maintenance Monitor Computer
STE	Stevens Point VDF Antenna Site
TI	Technical Instruction
TVRTM	Test Verification Requirements Traceability Matrix
VDF	Very High Frequency Direction Finder
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio Range
VFR	Visual Flight Rules